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Bart Dehaese

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Headstrong racing

How motor racing can show the way for safety in wider sport

Much is written about safety in motor racing, but few things are as important as the human brain.

Crash helmet design has evolved incredibly over the last 100 years, from cloth caps to leather skull caps to the evocative open-face helmet in the 1960s and today's full-face offering, which is clearly the most advanced safety element a driver can have to protect their all-important noggin. Or so I thought.

A few weeks ago, I was invited by the European Brain Foundation to attend an event in Brussels called 'Brain in Sport'.

My duty was to briefly explain what motorsport had done in its history for 'preventing and managing concussion and its consequences'.

It's a topic the FIA takes very seriously, and in June launched a campaign to raise awareness of concussion in the various regions around the world. With the FIA having examined the common causes of head injuries, I figured this would be an important topic, and I had plenty to contribute.

After coffee and a croissant on arrival, I noted two things reading through the day's schedule. Eighty per cent of the programme was dedicated to rugby, a sport where the damaging impacts of full contact have become a pressing topic. Along with the famous player, Serge Blanco, once dubbed the Pelé of rugby, I was about the only non-doctor in the room. This was not promising, I thought, but decided to stay in this rugby doctor lion cage anyway. I was curious.

Famous names

The speakers were neurosurgical, neurophysiologic, neuropsychologic, pathologic, physician and many other specialist doctors other than clinical biologists. Doctors Grzanna, Laureys, Marklund, Vajkoczy, and many more from all over the world who spoke, were famous names in their field, though probably not to you. Me neither.

Four hugely interesting hours of learning later, I knew quite a few surprising things about rugby, all nicely presented with statistics and understandable medical explanations.

A consequence of rugby played as it is currently leads to a fivefold increased chance of dementia, which amazed, and concerned, me.

After lunch, I raised my hand and said I was happy to hear all the bad things about the enormous amount of registered concussions but very surprised that not once had I heard the word helmet. Wow, did I raise a sensitive subject!

The helmet is arguably the single biggest life saver since the safety belt, yet still some high-contact sports seem unwilling to adopt its widespread use

Two men on the podium immediately reacted, grasped the microphones and fired the most convincing arguments at me. Firstly, that the helmet was declared completely useless. Secondly, that when you put heads in helmets, people simply play the game even harder and the injuries will be worse. Thank you.

Convincing answers? Not at all. I was thinking about an energy absorbing device: more than a scrum cap, and not one of those hard-shell types used in American football.

What I really struggled to understand was how rugby would become more harsh and violent if the players were to wear helmets. Why? That compares to the argument that seatbelts and roll hoops make drivers drive more dangerously - a take that was rejected in motor racing some 70 years ago.

Without a doubt, the improved safety outweighs the negative effect it may have on the most violent players on the pitch. And if concussions are caused by banging the head, the only logical way forward is to reduce the peak accelerations / decelerations by absorbing energy into a spongy material.

I had listened to four hours of the studies on the consequences of concussion, but not a single word on avoiding, or reducing, the cause.

During lunch, I bumped into one of the morning speakers and told him that I guess the helmet will be inevitable, because of all the data and analyses all of you have produced. After all, you can no longer tell the insurance company, and their lawyers, that you didn't know the risk.

It seemed to me that the doctors just missed the point. Their own studies will lead straight to measurements, and to the wear of a helmet (or some other technologically fancier third millennium device).

In the afternoon, during an intervention of a European Rugby Board member explaining the legal problems they now encounter ever more frequently, I tapped that doctor from lunch on his shoulder and said, 'and you'll end up with… the helmet.'

I started my own bit on the podium with an image showing three 'period' helmets and commented that in motor racing, wearing a helmet had been a no brainer. In racing, I said, we take so many very effective safety features for granted, resulting from 50 years' research, innovation and courageous execution, a long road never disturbed by mental corners.

In FIA working groups, at IndyCar, or in any other think tank, we may sometimes disagree on certain technical aspects of the regulations, or on adopting innovations, but when the subject is related to safety, there is *always* a feeling of urgency due to an overwhelming sense of responsibility to those involved.

Let's acknowledge that motorsport is immensely advanced on safety matters.

My job was to briefly explain what motorsport had done in its history for 'preventing and managing concussion and its consequences'

The next step

After the new engine regulations, Formula 1 also now has new chassis regulations for 2026. While they have attracted a lot of criticism, the FIA has a joker up its sleeve

By CHRISTIAN MENATH

The proportion of the combustion engine in the power unit has been significantly reduced

Renders: FIA

In Formula 1, eras are not just shaped by the teams and drivers competing, they are also defined by the technical regulations that underpin them.

In 2014, the series entered the turbo-hybrid power unit era, followed by the comeback of ground-effect cars in 2022. In 2026, both the engine and chassis regulations will undergo far reaching changes. There is no paradigm shift on either side, but the rule changes as a whole will lead to a 'moderate revolution', according to FIA single seater director, Nikolas Tombazis.

In truth, the revolution began several years ago. The FIA, Formula 1 and engine manufacturers sat around the table to negotiate the engine of the future. The manufacturers already involved favoured staying with their existing power units. The FIA and Formula 1, on the other hand, wanted to attract new manufacturers, and also wanted different engine regulations.

In issue V34N5 of *Racecar Engineering* we explained what the compromise on the engine side will look like in 2026. However, you have to understand the future power unit, and its history, to comprehend the chassis regulations of the future.

The combustion engine remains essentially the same. The 1.6-litre, V6 turbo, which has been in use since 2014, remains. However, the proportion of the combustion engine in the power unit has been significantly reduced. Currently, the ICE alone delivers a good 600kW but, by reducing the fuel flow rate, its output will be reduced in 2026.

At the same time, the output of the MGU-K will almost triple, from 120kW to 350kW, so the overall system output of the power unit will remain roughly the same.

By eliminating the MGU-H, the power units will become much less complex, which was the only way to win a new manufacturer in Audi. By using environmentally friendly synthetic fuels and increasing the output of the electric component, it was also possible to persuade Honda to make a comeback and Ford to agree to a partial entry, all without alienating the existing power unit suppliers. A win-win situation you might think. Well, not quite.

Power slide

The reason for that is the new engine rules have a downside. The battery capacity remains the same at 4MJ, and recuperation is capped at 8.5MJ, but the question is where does the energy come from?

At the heart of the new chassis regulations are more aerodynamically efficient cars, with drag reduced by 55 per cent and driver-controlled active aero elements

Currently, 4MJ is enough for 33.3 seconds of full e-boost yet, with almost three times the power coming from the MGU-K, the same amount of energy is only good for around 11.5 seconds. The fact that more recuperation is allowed only alleviates the problem a little.

In race trim, the maximum boost therefore remains for 24 seconds per lap. Even today, there is not enough energy for permanent maximum power at full throttle, but the proportion of the electric component is significantly lower. If the MGU-K stops today, just over 15 per cent of the system power will be missing. If the MGU-K stops in 2026, around 45 per cent will be missing. This imbalance is at the centre of the next chassis regulations.

The first revised engine regulations were adopted in August 2022. Numerous working groups then took care of the development of the corresponding chassis regulations. Corresponding, because the two were harmonised like never before in Formula 1 history. Red Bull Racing team boss, Christian Horner, recognised the danger early on.

Frankenstein's monster

'We need to ensure we're not creating a technical Frankenstein, which will require the chassis to compensate to such a degree with moveable aero and reduce the drag to such a level that the racing will be affected,' Horner warned after initial simulations were done with the new drive unit.

In June 2024, the FIA presented its 'technical Frankenstein'. At the heart of the regulations are more aerodynamically efficient cars. Aerodynamic drag is to be reduced by a massive 55 per cent.

The background to this is clear; for the limited energy to be sufficient, aerodynamic drag must be reduced, or the cars would be too slow on the straights.

Active aero

The reduction in drag is achieved through a series of measures. Active aerodynamics take centre stage. In pre-defined zones, the drivers are allowed to flatten the front and rear wings, similar to the current DRS.

The difference, however, is that the effect is much greater and activation is not dependent on the race situation. Each driver is allowed to activate the so-called X-Mode in the specified zones on each lap to reduce drag. When the brakes are applied, the active aero elements automatically re-position steeply into the wind again, activating the so-called Z-Mode, which brings with it plenty of downforce.

The original plan was to set only the rear wing in X-Mode, but that proved untenable.

'From our simulation work with the teams and their drivers, as soon as you have a rear wing that moves to reach the target drag level, it was clear you needed an active front wing to match the balance characteristics,' explains Jason Somerville, FIA head of aerodynamics.

Further complicating matters, the aerodynamic shapes themselves will also change. The current plan is to simplify the rear wing end plates. The beam wing will be banned, but the rear wing itself will be given a third element. The upper two elements may fold upwards in X-Mode, while the lower element is fixed.

The plan for the front wing is similar. Up to now, four individual wing profiles have been permitted here but, in 2026, there will only be three. Again, the upper two elements only will be allowed to move when the car goes into X-Mode.

Nimble car concept

The dimensions of the front wing, like those of the entire car, are changing dramatically. After the cars grew from 1.8m to 2m in width in 2017, the cars are taking another step back. Vehicle width in 2026 will be reduced to 1.9m. At the same time, the cars will be shorter, with the maximum wheelbase reduced from 3.6m to 3.4m.

In addition to a smaller frontal area, and the resulting lower air resistance, the smaller dimensions have another positive effect: the cars should become lighter and more agile again, which is why the FIA likes to talk about the 'nimble car' concept.

In recent decades, vehicle weight has only travelled in one direction, peaking at the car and driver weight of 798kg we have today. FIA president, Mohammed Ben Sulayem, originally set a reduction target of 50kg but, because the new engines are already over 30kg heavier, that target was too ambitious. Nevertheless, cars are to be 30kg lighter by 2026, with the minimum weight lowered to 768kg.

There would have been more savings potential with the tyres. A reduction in the inner diameter of the tyres from 18 to 16in was considered, but will now not happen.

Drivers will be able to flatten the front and rear wings in pre-defined zones around the racetrack. This is being called the X-Mode. Cars will automatically return to higher downforce Z-Mode when the brakes are applied

Currently, 4MJ is enough for 33.3 seconds of full e-boost yet, with almost three times the power coming from the MGU-K, the same amount of energy is only good for around 11.5 seconds

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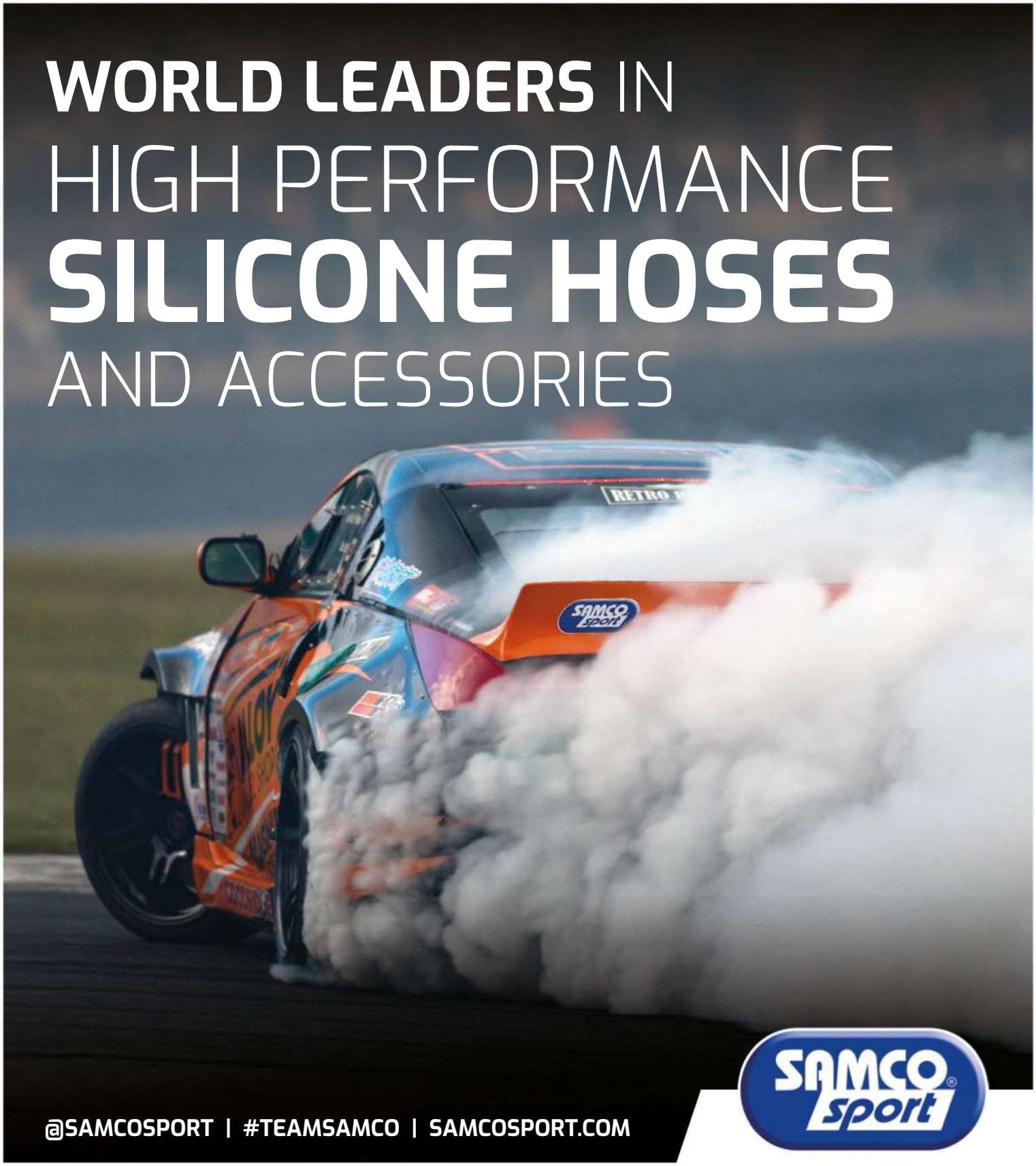

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Tyres were to go down from 18in to 16in diameter, but the FIA is concerned about traction issues so they're just being reduced eight per cent overall in width

'We don't want the tyres to be a source of concern in early 2026 with these new PUs, which will have a massive amount of power, especially in the traction phase,' explains Jan Monchaux, FIA single seater technical director. 'We simply were a little bit nervous that going much smaller could lead to some overheating issues, which then would become the only topic people and teams discuss at the start of '26.

'The reduction on the tyres is certainly less than we all hoped at one point, but we've already got enough changes through the power unit, the chassis and the aero regs, so taking another eventual risk there, we didn't feel was the right choice.'

That is why there are only minimal changes to the tyres for 2026. The rear tyre will shrink in width by 30mm, down from 405 to 375mm, while the front tyre will lose 25mm and be only 280mm wide in future. This corresponds to an eight per cent overall reduction in width.

Improved racing

On the other hand, more changes have been made to the aerodynamics, with the idea of putting racing back at centre stage.

'We believe we have had some deterioration of racing of late,' admits Tombazis. 'The aim of 2022 of having close racing has deteriorated, and cars can't follow each other as closely as we would have liked. We are planning to fix that.'

To do so, the width of the front wing is being reduced by 10cm and the end plates moved further inwards. The air will therefore be channelled past the front wheels on the inside, creating inwash instead of outwash. Additionally, front wheelarches will be removed, and part of the wheel bodywork will be mandated, to help achieve optimal wake performance.

Inwashing wheel wake control boards will sit on the front of the sidepods to assist with the control of the wheel wake. To prevent the aerodynamicists from torpedoing the targets again with performance development, the regulatory corset is even tighter than with the current chassis regulations.

There are also major changes to the floor. Its maximum width will be reduced by 15cm and a partially flat floor will be prescribed. The diffuser will also be reduced in size. This should have positive effects for the racing, as well as increasing driver comfort. Less dependence on ground effect should also tempt the engineers to set the cars up higher off the track and less stiff.

This is all well and good but, like everything in life, there is no advantage without a disadvantage. Above all, the measures to reduce drag cost downforce.

'We don't want the tyres to be a source of concern in early 2026 with these new PUs, which will have a massive amount of power, especially in the traction phase'

Jan Monchaux, FIA single seater technical director

In 2026, only three front wing profiles will be allowed: the lower element fixed, the upper two movable in X-Mode

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F1 cars have been steadily growing in size for years now, but the 2026 car will be 10cm narrower and the wheelbase dropped from 3.6 to 3.4m. Weight will also be reduced by 30kg

The FIA currently expects around 30 per cent less downforce compared to the current cars. That's why, when the regulations were introduced, there was an immediate outcry. Will Formula 1 be too slow as a result?

'I think the fears are accurate, because people are taking a snapshot of what the regulations are now on a piece of paper and making comments on the basis of what they see,' admits Tombazis.

Work in progress

However, what was presented by the FIA at the beginning of June is only the starting point. The FIA urgently needed an initial set of regulations on paper by that point so they could be presented to the World Motor Sport Council. Only up until this deadline could the FIA determine the rules without a further complicated procedure. For changes made after this date, the teams, Formula 1 and the FIA must find a majority. That is precisely why the FIA presented the World Council with regulations it knew were not perfect.

'We have full expectation to make some steps up for performance,' says Tombazis, 'and that's exactly why we've set the bar reasonably low to start with, so we can build on that with the collaboration of the teams.

'And to increase the downforce of these cars [by regulation] is actually quite easy. That's exactly the step we want to take.

'I understand the comments, but I don't think there's any concern that these cars will not be faster than F2, or anything like that. I think that will be 100 per cent resolved by the time we are in the final regs.'

There are practical reasons for approaching the project from below.

'We think it's going to be far easier in the next months to start increasing the freedom and review some aspects of the regulations, which potentially are far too constrained currently, than the other way around,' says Monchaux, confidently. 'They will all agree on having more freedom. If we had gone the other way around and effectively, let's say, have something like providing a lot of freedom in their ability to design the cars, we would potentially realise in October or November that it might put at risk some of the targets we want to achieve with these new regs.'

The FIA currently expects around 30 per cent less downforce compared to the current cars… Will Formula 1 be too slow as a result?

The teams can't complain about late changes because they won't be allowed to start developing the aerodynamics for the 2026 cars until 2025 anyway. By then, the status will have been changed from work in progress to largely finalised.

Target impossible?

Performance was not the only criticism, though. Above all, the new minimum weight caused the most discussion. Quite a few in the paddock believe the 768kg target cannot be achieved. Even with the current generation of vehicles, not all teams have reached the higher minimum weight.

The FIA expects a general reduction due to the car's smaller dimensions and lower cornering speeds. As a result, the loads on stressed members are lower and so parts can be lighter, provided safety does not suffer as a result, of course. Quite the opposite, in fact, as the focus there is once again being sharpened.

New front impact structure regulations introduce a two-stage component to avoid similar incidents to those in recent years where the entire structure has broken off close to the survival cell after an initial impact, leaving the car and driver unprotected from a subsequent strike.

Side intrusion protection has also been increased. The new specification gives improved protection around the cockpit and more than doubles that offered by the side of the fuel cell. These advances will need to be achieved without adding weight.

Additionally, roll hoop loads have been increased from 16*g* to 20*g*, brighter rear wing end plate lights will be introduced and GPS antenna re-positioned to improve sensitivity and to allow for future developments in active safety.

Despite the FIA's defences, the presented rules have so far met with little approval. The impression still prevails that something has to be compensated for on the chassis side to catch up with the engine changes.

Fortunately, the chassis regulations are still very much a work in progress, whereas the engine work has already run its course.

'There's a slightly different position in terms of governance in the power unit, because we are already under governance agreement in relation to the power unit regulations, which means any tweaks that may be necessary will still need to be agreed with the power unit manufacturers and cannot be done unilaterally,' notes Tombazis. 'Generally speaking, there is a good spirit of collaboration so, if some tweaks are needed, I'm confident the PU manufacturers will be collaborative there.'

As good as that collaboration may be, it will still not solve the fundamental energy problem. That would only be possible by significantly increasing the proportion available through the ICE again.

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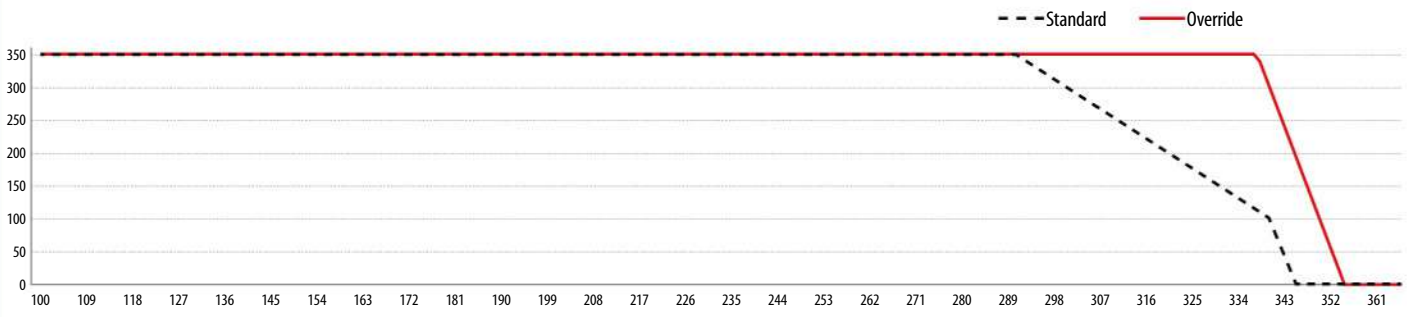

X-axis shows speed (km/h), Y-axis power (kW)

Graphic: Christian Menath using Datawrapper

'It's never too late,' says Horner, who has been wanting more combustion engine power from Red Bull Powertrains for some time. However, Mercedes F1 team principal and CEO, Toto Wolff, disagrees. 'Regulations have been decided on the power unit side. I think that's pretty clear,' he said.

Energy management

And so, on this side too, there are only efforts to mitigate unintended consequences, instead of tackling the source of the problem. The easiest way to do this is with energy management. Tombazis hinted at changes on this front in the V34N5 *Racecar* article, and they have since been incorporated into the power unit regulations.

On tracks with a particularly high proportion of full throttle (at least 3500m power limited), the output of the MGU-K may only be reduced by a maximum of 50kW per second. On all other track, 100kW per second applies. This is intended to ensure the energy is released more evenly.

Optimised for lap times, full power would be called up as soon as traction allows and run out at the end of the straight.

However, there is a risk that exorbitantly high top speeds could occasionally be achieved using X-Mode. For this reason, the regulations state that the maximum output of the MGU-K gradually reduces from 290 to 340km/h, dropping linearly from 350 to 100kW. Above 345km/h, the electric motor is no longer allowed to propel the car at all.

There is one exception to this – the so-called Override Mode.

As DRS is no longer possible as an overtaking aid, due to the new active aerodynamics, this significantly reduces the slipstream effect. The Override Mode has therefore been implemented in the regulations to allow overtaking manoeuvres to take place.

'We have a much bigger participation of PU manufacturers than before. That's something to be proud of'

Nikolas Tombazis, FIA single seater director

On the sporting side, the framework conditions for this still need to be worked out. On the technical side, in Override Mode, the MGU-K can deliver its full power up to 337km/h, and only stops at 350km/h. This usefully kills two birds with one stone as top speeds are kept in check and, at the same time, there is an overtaking aid.

To ensure the energy does not run out when overtaking, even more energy can be recuperated in Override Mode. Instead of the 8.5MJ, a limit of 9MJ per lap applies again, which was what was originally planned anyway.

So, 0.5MJ. This is probably the dimension upon which the engine manufacturers are still working on the regulations.

In retrospect, Tombazis does not see a major defect in the engine regulations.

'Yes, there are things we would like to have had more time to discuss but, as always, you have to act against time. Would it have been drastically different to where we now have it? I don't think so. I think we must stress the fact that we have a much bigger participation of PU manufacturers than before. That's something to be proud of.'

In order to keep the racing tight and exciting, an Override Mode with increased power and regen' capability will exist up to 350km/h to enable overtaking manoeuvres

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The record books now show that Ferrari took back-to-back outright wins at Le Mans in 2023 and 2024, further reinforcing that the Italian manufacturer is a force to be reckoned with at the French endurance race.

Its win this year was against one of the best entry lists of recent times. Nine manufacturers competed in the top class, four with the same car they ran in 2023. The BoP was effective, albeit not perfect, and rain caused mayhem for strategy on multiple occasions.

Introducing the new two-stage BoP process for the race was controversial but, as it turned out, very necessary. Teams had campaigned vigorously at the previous FIA World Endurance Championship round that it should be used, but technical leadership figures from the FIA and ACO were adamant that they were not even thinking about adjusting power over 250km/h.

Come the race, however, there it was on the table for all to see. Something had obviously changed, but what was it?

'We looked at the data from Spa,' said ACO competition director, Thierry Bouvet. Clearly, Ferrari had shown some of their true potential, and the engineers in charge reacted accordingly.

Ferrari was not happy about the last-minute about turn, but accepted it was 'part of the game,' as its technical director, Ferdinando Cannizzo, put it. '[The effect] is substantial, more than half a second,' added the Italian. 'The point is that the performance you have in a straight line is always good, it's independent of the weather, or grip levels. You can count on it. By having straight-line performance, you also gain raceability, so, for example, managing the traffic is easier.'

The Ferrari 499P was clipped by 1.7 per cent power above 250km/h. Driver, James Calado, said the car usually spent around 40 seconds above that speed during a lap of the 13.626km track.

Conversely, the Toyota GR010 Hybrid gained 0.9 per cent power. It was able to match Ferrari at top speed and could defend position into a corner, even when the 499P had the slipstream.

Flexible questions

Pre-race there was talk of flexible ride heights, but these were put to bed early in the week. The use of non-linear spring rates was discussed but they are not legal and, besides, managing the performance with such flexibility would be more than most teams could handle. Finally, flexible rear bodywork was also investigated but the Hypercars were found to conform to the regulations.

There were also rumours of gasses being put into tyres that were not previously thought of, including talk of Porsche finding a clever new solution. Michelin issues tyres containing dried air but teams change to nitrogen before fitting them to the car. Nitrogen is stable and able to handle the humidity from the tyres better than air, but there was a feeling that Porsche had a different solution. Certainly, there has been a clear difference in the first half of the year between the performance of the works and customer Porsche 963s, but figuring out why that is has been challenging.

Ferrari takes victory again

The Italian constructor scored back-to-back wins at the 24 Hours of Le Mans, this year against the toughest of competition

By ANDREW COTTON / DANIEL LLOYD

Analysis by PAUL TRUSWELL

Nine manufacturers competed in the top class… BoP was effective, albeit not perfect… and the weather caused mayhem

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There were no intermediates, so teams were focused on making the softs work in damp conditions as rain was (correctly) predicted

Many believed that Porsche was hiding performance, but pre-race the drivers knew the 963 lacked straight-line speed

Customer teams say the factory cars have become worse on tyre warm up as the year has progressed, but the rumours about what is used to inflate the tyres remain.

One leading engineer of substantial experience pointed towards the fact that Penske also runs IndyCar and NASCAR teams, both series in which fast tyre warm up is required after a pit stop. It's one of the question marks still in the book.

Porsche customer team, JOTA, had a nightmare start to its race week when Callum Ilott was apparently distracted by a warning light on the dashboard and crashed during Wednesday's practice session. A hole in the chassis meant a change was required, and Porsche offered the test car that had earlier taken part in a demonstration run in town. The rules required it be completely stripped, and only the tub replaced by the JOTA team.

Two sleepless nights later, the car undertook a shakedown run at Le Mans Arnage Airport on Friday evening. JOTA then had to sort out a few issues with the electrics but, incredibly, the completely rebuilt car was deemed ready to take the start of the race at 4pm on Saturday afternoon.

Cadillac blotted its copybook somewhat during the test day when its crews ran slowly, seemingly to try to influence the BoP. The trio of Cadillac V-Series.Rs finished the test day 14th, 16th and 19th fastest, nearly 2.5s off the pace. The strategy was obvious. The performance cheered up in qualifying, and cars set second and third fastest times overall, beaten only by Kévin Estre's Porsche.

The no.2 Cadillac, driven by Earl Bamber, Alex Lynn and Alex Palou, was the team's racecar from 2023, fitted with newly-made bodywork for this race. However, Cadillac was worried after Lynn touched the wall at Tertre Rouge on Wednesday night. Each Prototype had three noses for the race week, and the team planned to change them mid-race to ensure a good aero balance throughout the 24 hours. The blue Cadillac, however, was down to two before qualifying even began.

Tyre choices

Michelin brought all three slick tyre choices to the race – soft, medium and hard – plus a wet. There were no intermediates, so teams were focused on making the softs work in damp conditions as rain was (correctly) predicted.

Cadillac tried to play the BoP game early in the week and picked up pace in qualifying, running last year's V-Series.R in fresh clothes

Ferrari was confused over Toyota's tyre strategy in qualifying, after which the top eight cars went through to the television-friendly Hyperpole shootout. Toyota took off the soft tyre after one run and fitted the medium, even though the track and ambient temperatures were dropping. It was clear the soft would be the preferred option.

Both Toyotas missed out on Hyperpole. Brendon Hartley encountered traffic on his remaining runs and Kamui Kobayashi crashed, bringing a red flag that lost him his qualifying times. It was not Toyota's finest hour.

BMW headed qualifying as Dries Vanthoor found pace, despite the manufacturer admitting to handling issues with the car.

'The biggest problem is on the brakes,' said BMW's reserve driver, and IMSA driver, Nick Yelloly. 'Porsche had a similar issue last year, and then figured it out. Ours is quite similar, but we have not found a direction that has cured it, or improved it. We played with the idea in different tests, but never got it to work the way we want.

'It's settings mostly, and understanding them – knowing how complex or not you need to be – because there is a fine line between the two to be able to get the car to handle like a normal racecar.'

That said, BMW clearly nailed it eventually, as Vanthoor topped qualifying and was fastest through the third sector. Even the WRT factory team was surprised at the result, but said it would take it. Nevertheless, BMW knew it didn't have the raceability of the LMH cars, notably Toyota and Ferrari, and did not expect to be a challenge over the 24 hours.

All cars had, as usual, been lowered for qualifying as skid plank wear is not an issue in a one-hour session as it is in a 24-hour race. Again, the rumour was that LMDh cars like the BMW needed to run low to perform well, and that the LMHs had more versatility. Naturally, this was denied by the LMH constructors.

Of the other newcomers, it was obvious early on that the Alpine was struggling with

The 2024 race was the first in Le Mans history to feature more than two cars on the lead lap at the flag. In fact, it was a remarkable nine

The Toyota GR010 Hybrids could match the Ferrari's pace, but time was lost on track and the team finished the race an unhappy second

reliability and, after the race, its motorsport vice president, Bruno Famin, admitted the team had not expected to finish the race.

The first problem in practice was the throttle jamming closed. Preferable to being jammed open, but the team knew the Mecachrome engine itself was a bigger issue.

In testing, the A424 had suffered a valve failure, and the team knew there was a strong chance it would happen again in the race. The only surprise was when it came, for both cars, after slightly more than 1000km of running.

The team had hoped to impress on pace, at least, but Famin noted there were plenty of areas that needed to be improved on the team and operation side to compete for wins.

Lamborghini replaced a tub after the test day when the Ligier-made part was found to have a fault. Rather than go into the race with a problem, the team elected to build up a new car, which was then fitted with lightweight bodywork, bringing it closer to the weight limit prescribed by the BoP table.

Although the SC63 was not particularly quick, to the frustration of its drivers, both cars reached the finish without major issues.

As for Peugeot, the French manufacturer was given a helping hand with the BoP, compared to Spa and Imola, but neither car made it to Hyperpole. The fastest of the 9X8 Evos qualified 15th, 1.7s off Vanthoor's time, the other in 20th, 2.7s down and only ahead of one Lamborghini and the Isotta Fraschini.

A matter of survival

Pre-race patter from the manufacturers was that the race would be more a matter of survival than outright performance. Full race pace was not anticipated to be revealed until Sunday morning at the earliest, maybe even the afternoon, and only if it stayed dry. Each manufacturer therefore had a race strategy of keeping their cars healthy until 'go time'.

That did not prevent Ferrari rolling the dice as early as Saturday night. When heavy rain swept the track, it elected to keep all three cars out on soft slicks while other teams pitted for wets. Toyota said afterwards that it was better to lose a minute making a cautious decision than to lose a car, and ultimately Ferrari didn't make any gains taking the more risky route in that scenario.

Alpine demonstrated potential with its new LMDh car, the A424, but engine failures saw both retire inside six hours

Heavy overnight rain led to a lengthy safety car period in the early hours of the morning, which lasted until nearly 8am. By that point, both BMWs were out of contention: one retired after a nerf from the leading Ferrari (the yellow AF Corse Ferrari 499P of Robert Kubica), while Robin Frijns crashed the other. The latter BMW was repaired and did reach the flag, but 125 laps down and not classified in the final results.

The two Alpines had also fallen out of the race with their predicted engine issues, but reliability among the others was surprising. Crashes accounted for Felipe Nasr's Porsche and Pipo Derani's Cadillac on Sunday, both losing traction at the front on the damp track approaching Indianapolis corner and striking the barrier. Again, the latter was repaired and finished the race in 29th position overall.

It took until hour 19 before reliability issues struck the no.3 Cadillac, which retired with a holed oil tank, and hour 20 for the AF Corse Ferrari to stop with an electrical failure at the front. The team said the brakes had caught fire, but the brown smoke and mechanics wearing rubber gloves gave the game away, as did the smell in the pit.

As the race wound down, it was clear it was still all to play for. The 2024 race was the first in Le Mans history to feature more than two cars on the lead lap at the flag. In fact, it was a remarkable nine.

Strategy gains

To win Le Mans you need a car that is quick on the straights and fast through the corners. You also need to a car that is reliable and to avoid making mistakes that result in penalties or damage. In addition, you have to be in the right place at the right time, on the right tyres, with the right settings. And you need to anticipate changes in the weather. A little bit of luck when you need it helps, too.

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Performance this year was slower overall than in 2023… Clearly, the two-stage BoP had an effect

Ferrari's satellite 499P, fielded by AF Corse, which also runs the factory cars, was among the victory contenders until an electrical fire

To make an analysis of all these factors is impossible. To explain why one car wins and another doesn't involves a plethora of interacting minutiae, especially when no team at this year's Le Mans achieved anything close to the perfect combination.

The tables here focus on performance, mainly lap times, but also looking at Sector 2 of the circuit, which comprises the Mulsanne Straight and the two chicanes that break it up. Wherever it is reasonable, average data is taken, which removes the anomalies thrown up by observation of a single data point.

An initial observation is that performance this year was slower overall than in 2023. Ferrari, Toyota, Porsche and Cadillac all managed laps under 3m 28s in last year's race, yet the best lap this time around was nearly a second slower. Pole position in Thursday evening's half-hour Hyperpole was, similarly, 1.7s slower than last year.

Clearly, the two-stage BoP had an effect, even if it wasn't noticeable during the test day which was held one week before the race.

As was the case last year, Ferrari and Toyota clearly had the best cars. In terms of outright performance, the no.51 Ferrari was quickest, but the no.7 Toyota was very close.

Porsche, specifically the no.6 car (in the hands of Laurens Vanthoor and Estre), was not far behind in third, and the Cadillacs, despite showing promise early in race week, fell to fourth-best manufacturer in the race.

Lamborghini performed marginally better than Peugeot, which must have been a disappointment for the French brand after its respectable showing last year, while neither BMW nor Alpine completed enough laps to make inclusion in the data table reasonable.

The need for speed

With the updated BoP regulations this year, as well as the number and competitiveness of the cars, top speed down the straights was more important than ever. The speed trap at Le Mans is situated just before the first chicane on the Mulsanne Straight, and has been notoriously inaccurate in the past, which is why the table shows the average of the best five speed trap readings.

It is illuminating, and perhaps more useful, to compare this data with the Sector 2 times, and even more so to look at an average of the top 60 per cent of readings here, which will include data recorded during the wet and night-time periods of the race, but excludes running behind the safety car. However, please note that this data is not valid for those cars that did not complete the full race distance, hence it is not shown.

Again, it is clear that Ferrari and Toyota had the fastest cars (a very useful attribute for making up track position) but in this case it was the no.51 Ferrari and the no.8 Toyota that had the better straight-line speed than their respective sister cars, perhaps the no.83 AF Corse Ferrari even more so.

The Rising Average graphs show the performance profile over the fastest laps. For the sake of legibility, the mid-range laps, from 3m 34s to 3m 40s, are not shown, but examination of this data reveals that three cars - both factory Ferraris and the no.8 Toyota - are consistently around 0.7s clear of the rest. Through much of the wet-weather running, this is where gains could be made.

In the end, the race came down to the final five and a half hours. When the safety car pulled in at the end of lap 225, the top eight Hypercars were running together, as close, if not closer, than they were at the start.

Interestingly, those eight cars did not include the no.51 Ferrari, which was stuck in the safety car queue behind three GT cars, in ninth place overall.

Even then, it was not a straight run from there to the flag as two further rain showers and a Full Course Yellow period interrupted proceedings. This had the effect of slowing lap times by more than 20s per lap, and allowing both the no.50 Ferrari and no.8 Toyota to stretch their stints to 13 laps.

Nevertheless, from the analytical point of view, it is most instructive to look at the performance in those final 80 or so laps, which is shown in **table 2** on p24.

Ironman of the race was Laurens Vanthoor, who drove the no.6 Porsche for a total of 11h 44m, more than an hour longer than any other driver in the field spent at the wheel.

The Porsches, including JOTA's rapidly rebuilt car, ran well but were eventually outpaced by the Toyotas and Ferraris

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Table 1: Hypercar gap graph

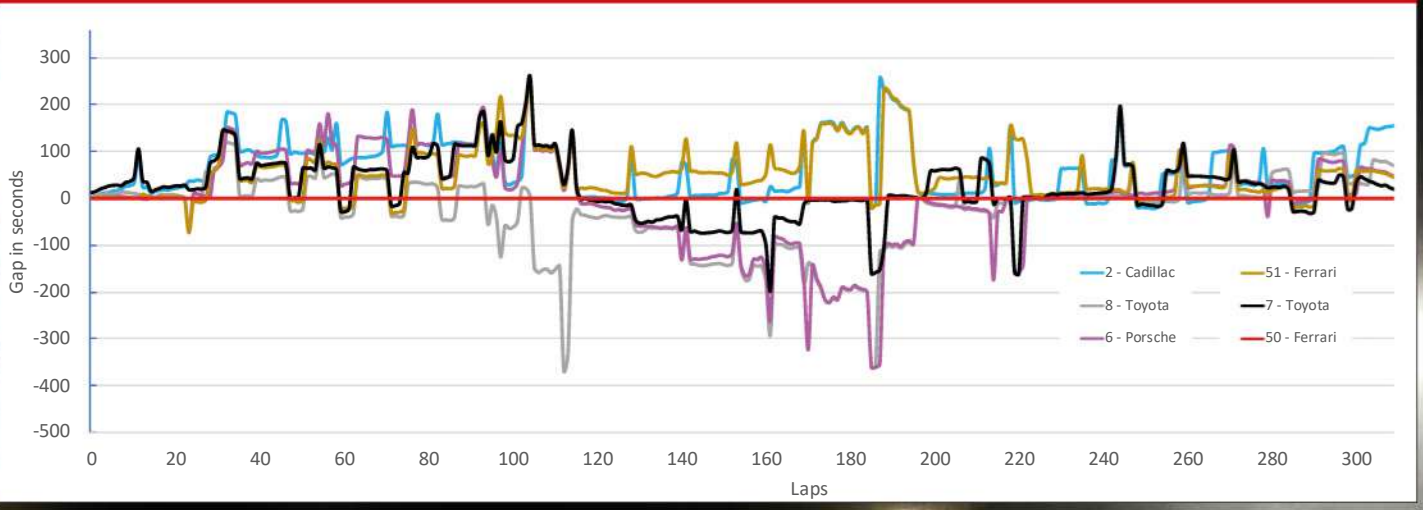


Table 2: Hypercar performance over the final 80 laps

Rank	Finishing position	No.	Team	Driving sequence	Average of best 20 laps	Percentage	Pit stops
1	2nd	7	Toyota Gazoo Racing	Kobayashi/Lopez	3:29.999	0.00%	8
2	3rd	51	Ferrari AF Corse	Calado/Pier Guidi	3:30.365	0.17%	7
3	7th	2	Cadillac Racing	Bamber/Palou/Lynn/Palou	3:30.759	0.36%	7
4	5th	8	Toyota Gazoo Racing	Buemi/Hartley/Buemi	3:30.775	0.37%	7
5	1st	50	Ferrari AF Corse	Fuoco/Molina/Nielsen	3:30.790	0.38%	7
6	4th	6	Porsche Penske Motorsport	Estre/Vanthoor/Estre/Vanthoor	3:31.014	0.48%	7
7	9th	38	Hertz Team JOTA	Hanson/Rasmussen/Button	3:31.312	0.63%	9*
8	8th	12	Hertz Team JOTA	Stevens/Ilott/Nato	3:31.652	0.79%	7
9	6th	5	Porsche Penske Motorsport	Makowiecki/Christensen/Campbell	3:31.683	0.80%	8*

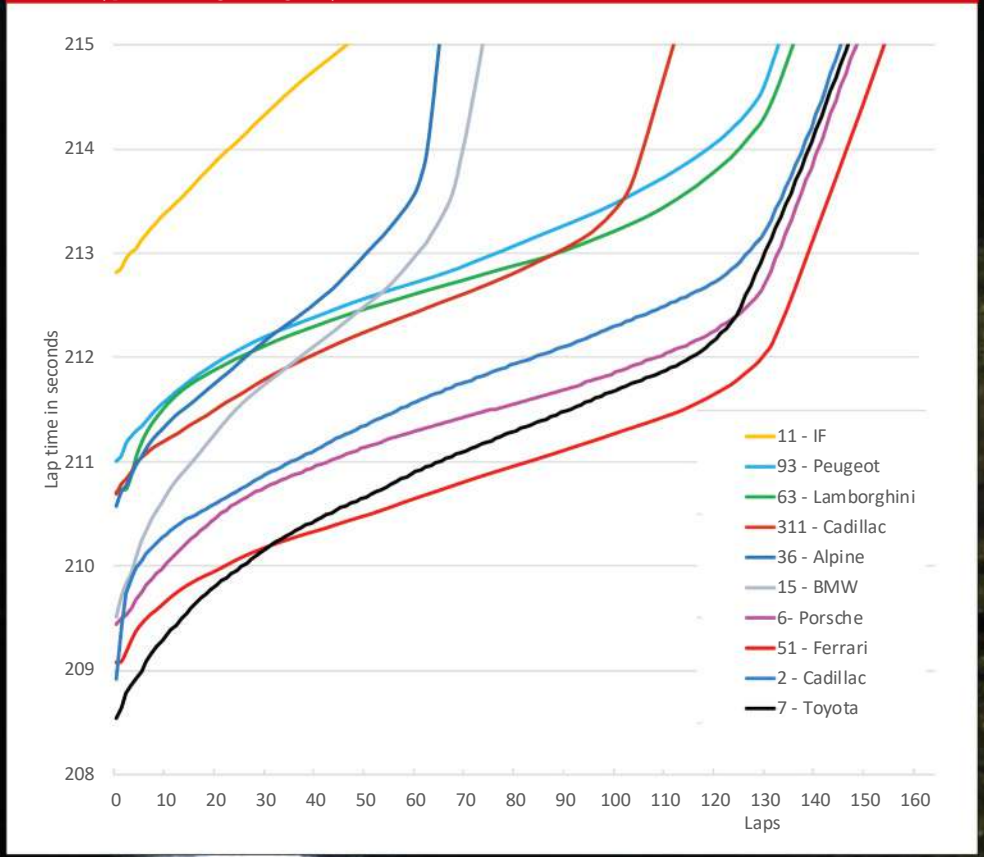
*includes drive-thru penalty

Table 3: Hypercar performance by top speed

Pos	No.	Team	Car	Top Speed (kph) (Best 5 Average)	Percent	Sector 2 Best (secs)	Percent	Sector 2 60% Average	Percent
1	50	Ferrari AF Corse	Ferrari 499P	340.6	0.58%	80.062	0.19%	81.339	0.03%
2	7	Toyota Gazoo Racing	Toyota GR010 Hybrid	342.1	0.15%	80.074	0.20%	81.448	0.16%
3	51	Ferrari AF Corse	Ferrari 499P	338.5	1.20%	80.210	0.37%	81.427	0.14%
4	6	Porsche Penske Motorsport	Porsche 963	334.1	2.48%	80.484	0.72%	81.871	0.68%
5	8	Toyota Gazoo Racing	Toyota GR010 Hybrid	342.6	0.00%	79.954	0.05%	81.315	0.00%
6	5	Porsche Penske Motorsport	Porsche 963	334.7	2.31%	80.415	0.63%	81.818	0.62%
7	2	Cadillac Racing	Cadillac V-Series.R	336.0	1.93%	80.225	0.39%	81.774	0.56%
8	12	Hertz Team JOTA	Porsche 963	338.9	1.08%	80.593	0.85%	82.130	1.00%
9	38	Hertz Team JOTA	Porsche 963	335.3	2.13%	80.480	0.71%	81.939	0.77%
10	63	Lamborghini Iron Lynx	Lamborghini SC63	333.9	2.54%	80.673	0.95%	82.183	1.07%
11	94	Peugeot TotalEnergies	Peugeot 9X8	338.3	1.26%	80.835	1.16%	82.344	1.27%
12	93	Peugeot TotalEnergies	Peugeot 9X8	339.1	1.02%	80.505	0.74%	82.056	0.91%
13	19	Lamborghini Iron Lynx	Lamborghini SC63	336.0	1.93%	80.432	0.65%	81.996	0.84%
14	11	Isotta Fraschini	Isotta Fraschini Tipo6-C	340.2	0.70%	80.930	1.27%	83.365	2.52%
15	311	Whelen Cadillac Racing	Cadillac V-Series.R	335.3	2.13%	80.622	0.89%		
16	99	Proton Competition	Porsche 963	333.9	2.54%	80.573	0.83%		
17	83	AF Corse	Ferrari 499P	340.4	0.64%	79.912	0.00%		
18	3	Cadillac Racing	Cadillac V-Series.R	332.8	2.86%	80.650	0.92%		
19	4	Porsche Penske Motorsport	Porsche 963	337.1	1.61%	80.292	0.48%		
20	15	BMW M Team WRT	BMW M HYBRID V8	336.6	1.75%	80.191	0.35%		
21	20	BMW M Team WRT	BMW M HYBRID V8	336.0	1.93%	80.791	1.10%		
22	36	Alpine Endurance Team	Alpine A424	339.1	1.02%	80.138	0.28%		
23	35	Alpine Endurance Team	Alpine A424	336.6	1.75%	80.474	0.70%		

Again, it is clear that Ferrari and Toyota had the fastest cars, but in this case it was the no.51 Ferrari and the no.8 Toyota that had the better straight-line speed than their respective sister cars

Table 4: Hypercar rising averages by best car from each manufacturer



On paper, the result looks incredible, but… some of the Le Mans magic has been lost

Peugeot's 9X8 led on its Le Mans debut last year but was nowhere in the Hypercar fight with its new, winged upgrade package in '24

The performance of the no.7 Toyota in the closing stages was noteworthy, as José María López and Kobayashi chased down the leading no.50 Ferrari. López, subbing for an injured Mike Conway, briefly spun at Dunlop with just under an hour remaining, costing his car around 14 seconds. Coincidentally, that was Nicklas Nielsen's winning margin.

The Gap Graph provides an excellent overview of the whole race, even though, for clarity, it only shows the top five finishers, plus the Cadillac that finished seventh.

Eight different cars led the race at some point – all three Ferraris, both Toyotas, two of the Porsches and the no. 2 Cadillac. The graph shows that no single car had any significant lasting advantage, and how the race ebbed and flowed. This was particularly true during the night, when the Ferraris seemed to fade somewhat, only coming back into contention after lap 230 (at 11am on Sunday morning).

We cannot conclude our analysis without a word about the Isotta Fraschini, of which not a great deal was expected, pre-race.

The Michelotto-built LMH car finished nine laps behind the winning Ferrari, however it did so without any major drama. Its longest pit stop was 2m 41s (except when it was held at the end of the pit lane during a safety car period), and only one other pit stop was over two minutes. It had good straight-line speed but, interestingly, could not match its time through the length of the Mulsanne Straight to its top speed at the speed trap.

Ferrari fortune

Ferrari said after the race that every one of the decisions made on Sunday fell its way with the winning no.50 car, including the timing of pit stops to switch to wets and its management of the safety cars.

Toyota, on the other hand, was unhappy that its cars had been blocked by other Ferraris but admitted it had, once again, been beaten against strong opposition. That will undoubtedly rankle with the management.

At one stage, Hartley was tipped into a spin by Alessandro Pier Guidi, for which the Ferrari driver was given a five-second penalty; spare change in relation to Hartley whose no.8 Toyota lost 35 seconds recovering.

The significance was that the no.50 Ferrari had an issue with its passenger door and was forced by the race director to pit and fix it. Hartley and Pier Guidi would likely have been competing for the win had the loose door not turned out to be a quick fix.

Porsche had an expectation that it would be close and able to focus on performance rather than reliability this year, but came up short. Like Cadillac, it pointed at the BoP as one reason for not winning, but did also admit to making mistakes in the pit.

'Congratulations to Ferrari, they were better than us and we were simply not good enough,' said Porsche factory LMDh director, Urs Kuratle. 'We made plenty of mistakes but I am still proud of the team. It was close, 40 seconds to the winner.

'We had four cars in the top 10 but no one cares about that. It was close but we didn't win, so in this case we messed up.

'Top speed, the others are faster. It was way closer than everyone was shouting about, but Porsche is missing top speed. That was one factor, but we made some tyre calls that were not okay at the time. It is a 24-hour sprint race, and it was still a great race.

'The hiding story was big all weekend. I hope everyone looks at the numbers in the right way, and draws their conclusions. It was better than last year, and we go step by step.'

The competition was fierce, the racing was excellent, but old-style race strategy is no longer what Le Mans is all about. The cars are reliable, BoP keeps them close and driver mistakes were minimal. The American-style safety car procedure means there is no point risking anything until Sunday morning, it is all about keeping the car clean until then.

On paper, the result looks incredible, but there is no doubt with the current rules that some of the Le Mans magic has been lost.

Newcomers Isotta Fraschini and Lamborghini both put on a good, solid show, finishing the race and showing reliability

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United delighted

Safety cars and tightly-controlled regulations helped keep the racing close in LMP2

The LMP2 class at Le Mans arguably reached its peak between 2021 and 2023, when several Hypercar-bound competitors were racing. The likes of JOTA, Team WRT, Penske and Prema have since moved on to the top category, taking a host of star drivers with them. While that slightly dimmed the spotlight on LMP2 this year, the level of competition didn't feel diluted as only 40 seconds separated the top five.

Multiple safety cars, mixed conditions and a field of identical ORECA 07 Gibsons, which this year had to use the same mandatory gear ratio set, helped keep things close between the experienced teams still involved.

The shift of LMP2 talent to Hypercar also opened the door for newcomers to shine. Two members of the winning United Autosports line up were Le Mans debutants. The victorious no.22 ORECA from the West Yorkshire-based squad, which last won the class in 2020, only emerged as a front runner on Sunday afternoon.

For most of the race, it was content to simply stay on the lead lap, taking a cautious approach through changeable weather. After its Silver-rated driver, Bijoy Garg, completed his mandatory six hours behind the wheel, United started to think about how to topple the tranche of other victory contenders that included Inter Europol Competition, Cool Racing, AF Corse and Vector Sport. Having adopted a conservative strategy for much of the race, the team asked its other Le Mans rookie, Nolan Siegel, to initiate a final push with four hours to go.

'We had a handle on where everyone else was on strategy and pace, so we asked him to step it up on track,' said United Autosports co-owner, Richard Dean. 'We felt there were a few really good teams and driver line ups that could step it up too, and were surprised when they didn't. As we pushed harder, we seemed to have more in reserve than anybody else.'

United Autosports saw its Pro-Am contender drop out of the mix early on, but managed its no.22 car perfectly in changeable conditions to take LMP2 class victory, its first since 2020

Luxury gap

Once Siegel had elevated the no.22 ORECA into the lead, he handed the reins to Oliver Jarvis, an experienced Le Mans hand and previous LMP2 winner, to bring the car home through the rain. At the line, United was 18 seconds clear of its closest rival, Inter Europol, although the gap could have been larger had the team not elected to pit for fresh wet tyres.

'When it was bad rain towards the end, we had the luxury of enough margin to put new wets on, when everybody else couldn't afford to lose time changing tyres as well as fuel,' said Dean. 'They double stinted their wets on the last stint in an attempt to close that gap, but we had the luxury of allowing them to do that. We knew we could give away 20 seconds.'

United even told its mechanics to take their time during that final pit stop to make doubly sure there were no mistakes in the tyre change.

'When we had a new set of wets at the end, some were on a third stint,' added Dean. 'We knew at that point, barring any mistakes, we had the race.'

Whilst United successfully took the slow burn approach, the quickest LMP2 out of the blocks was the Vector Sport ORECA, which stayed on slicks during the first bout of rain after a call from Le Mans stalwart, Patrick Pilet, who was behind the wheel.

As the others pitted for the safer wet tyre option, Pilet tamed the conditions on the spec Goodyear slick and Vector's lead grew to over 90 seconds, only to contract when the safety car came out in the seventh hour.

Vector was then slapped with a drive-through penalty for overtaking under that safety car, although it recovered on Sunday and was back in the lead fight with Inter Europol.

The two teams were locked in step until midway through the 20th hour, when IDEC Sport jumped ahead of both during a round of pit stops. The French squad kept a used set of slick tyres on through a driver change when its rivals didn't, and vaulted into a lead of around 20 seconds.

However, IDEC (blue in graph) set its tyre pressures too low during the subsequent rain and dropped back again, eventually finishing third behind Inter Europol and United. The Inter Europol car, meanwhile, went from the lead to a lap down in the fourth hour when its left front wheel detached.

By staying out on slicks when the rain came, it was in position to return to the lead lap under the safety car, but the Polish-flagged squad didn't have the pace to overcome a charging United ORECA, lapping nearly half a second slower, on average, than the other podium finishers.

Cool Racing was another front runner with the pace to win, but a windscreen wiper motor malfunction led to a half-hour pit stop that punted the team down to 12th position towards the end.

LMP2 Pro-Am cars are slower on average because their line ups must include a Bronze-rated amateur driver. However, some of them were able to challenge the 'overall' LMP2 entries by soaking up the Bronze driver's stint time under safety cars before letting their professional drivers make inroads.

AF Corse came closest, finishing 35 seconds behind the winner in fourth, and was running second outright until its penultimate pit stop with an hour and 20 minutes to go. It emerged behind IDEC Sport and Inter Europol and remained there.

United Autosports' no.23 car was one of the fancied entries in Pro-Am but a stone from a spin in the gravel trap broke a pulley. Repairs were made, but the car finished the race 25 laps down.

LMP2 gap graph

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Porsche

Manthey Racing lost one of its Porsche 911 GT3 Rs to gearshift actuator issues, but the team's no.91 car ran steadfast to the flag

Manthey masters new class

Experienced Porsche squad resists stiff competition to win the first Le Mans 24-hour race for GT3 cars

When the chequered flag fell at the end of the maiden 24-hour race for GT3 cars at Le Mans, it was a team with history in the event's preceding GTE era that were celebrating.

Manthey Racing, a three-time winner in the GTE-Pro category, prevailed in the new LMGT3 class, despite losing one of its front-running Porsche 911 GT3 Rs to a gearshift actuator issue on Sunday morning. The German squad's sister no.91 car remained in the hunt and resisted a challenge from the no.31 BMW M4 GT3 in the closing hours to take the class win.

'We made no mistakes on the no.91,' said Manthey managing director, Nicolas Raeder. 'The no.92 had the same speed. We made no mistakes there either, with a good performance from safe drivers. The car was good on the tyres, and we found a very good set-up we could drive on unbelievably long.'

Tyre supplier, Goodyear, was confident before the race that the LMGT3 field could exceed the double stints they would need to do, based on the slick tyre allocation. And many cars achieved that. Raeder noted that the Porsches actually did three and a half stints on some tyre sets, though WRT found three was the maximum for its BMWs.

That might have been significant to the outcome of a completely dry race, based on the time saved by changing tyres less frequently, but rainfall during the night and on Sunday afternoon turned it into a battle on the unlimited supply wets for those that survived.

In the end, the Belgian WRT squad admitted it didn't have the pace to match Manthey, having spoken earlier in the event about lacking straight-line speed, which is essential at Le Mans.

'There was nothing wrong in terms of race execution,' said WRT co-sporting director, Kurt Mollekens, after the finish. 'Sector 2 was weak for us and nothing changed since practice. We were missing about 0.5 seconds to be comfortably racing Manthey.'

Despite that admission, performance data shows the BMW was still the closest car to the Porsche, its average lap times within 0.2 per cent.

Like Manthey, WRT started with two swords in the fight but ended with only one. The no.46 BMW retired following an accident in the ninth hour when Ahmad Al Harthy ran wide at the Dunlop Chicane, collecting dirt on his car's slick tyres and compromising their grip. This caused him to lose control where the track crests under the Dunlop bridge, the car snapping left into the tyre barrier.

LMGT3 performance

Pos in class	No.	Team	Car	Laps	Best Lap	Percent	Ave Best 20% of green laps	Percent	No of Pit Stops	Total Time in Pit
1	91	Manthey EMA	Porsche 911 GT3 R LMGT3	281	3:57.435	0.00%	3:58.576	0.00%	28	44:38.760
2	31	Team WRT	BMW M4 LMGT3	280	3:57.845	0.18%	3:58.959	0.16%	27	44:37.212
3	88	Proton Competition	Ford Mustang LMGT3	280	3:59.109	0.71%	4:00.358	0.75%	29	45:51.958
4	44	Proton Competition	Ford Mustang LMGT3	280	3:59.206	0.75%	4:00.294	0.72%	28	49:33.963
5	85	Iron Dames	Lamborghini Huracan LMGT3 Evo2	279	3:59.584	0.91%	4:01.003	1.02%	26	42:54.135
6	55	Vista AF Corse	Ferrari 296 LMGT3	279	3:58.474	0.44%	3:59.480	0.38%	30	48:14.675
7	78	Akkodis ASP Team	Lexus RC F LMGT3	279	4:00.236	1.18%	4:01.274	1.13%	31	57:16.209
8	155	Spirit of Race	Ferrari 296 LMGT3	279	3:57.429	0.00%	3:59.318	0.31%	28	45:58.725
9	777	D'Station Racing	Aston Martin Vantage AMR LMGT3	279	3:58.711	0.54%	4:00.186	0.67%	28	46:42.374
10	87	Akkodis ASP Team	Lexus RC F LMGT3	279	3:58.996	0.66%	4:00.411	0.77%	28	45:04.163
11	82	TF Sport	Corvette Z06 LMGT3.R	278	3:58.539	0.47%	4:00.388	0.76%	28	51:31.289
12	86	GR Racing	Ferrari 296 LMGT3	278	3:57.482	0.02%	3:59.524	0.40%	30	44:53.262
13	70	Inception Racing	McLaren 720S LMGT3 Evo	275	3:58.184	0.32%	3:59.408	0.35%	29	1:21:12.913
14	92	Manthey PureRxcing	Porsche 911 GT3 R LMGT3	273	3:58.075	0.27%	3:58.900	0.14%	31	1:14:48.908
15	81	TF Sport	Corvette Z06 LMGT3.R	267	3:59.755	0.98%	4:01.907	1.40%	29	1:19:50.642
16	60	Iron Lynx	Lamborghini Huracan LMGT3 Evo2	258	3:58.703	0.54%	4:00.358	0.75%	26	2:10:55.036
17	77	Proton Competition	Ford Mustang LMGT3	227	3:57.562	0.06%	3:59.775	0.50%	23	4:45:56.285
18	59	United Autosports	McLaren 720S LMGT3 Evo	220	3:59.661	0.94%	4:01.024	1.03%	N/A	DNF
19	95	United Autosports	McLaren 720S LMGT3 Evo	212	3:59.736	0.97%	4:01.012	1.02%	N/A	DNF
20	27	Heart of Racing Team	Aston Martin Vantage AMR LMGT3	196	3:58.793	0.57%	4:00.223	0.69%	N/A	DNF
21	66	JMW Motorsport	Ferrari 296 LMGT3	112	3:58.162	0.31%	4:00.270	0.71%	N/A	DNF
22	46	Team WRT	BMW M4 LMGT3	109	3:59.663	0.94%	4:00.681	0.88%	N/A	DNF
23	54	Vista AF Corse	Ferrari 296 LMGT3	30	3:59.650	0.94%	4:00.885	0.97%	N/A	DNF

WRT later admitted it was wrong to put its non-professional, Bronze-rated driver out on slicks at that point in the race.

Retirement home

The no.46 BMW was one of six retirements in LMGT3. Despite winning LMP2, United Autosports lost both of its podium-contending McLaren 720S GT3 EVOs in rapid succession during hour 19.

The no.59 McLaren was consistently quick until it suffered a transmission issue, whilst the no.95 withdrew when it stopped on track with a loss of drive. Because it didn't make it back to the pits, the diagnosis was delayed as the team waited to receive the car, although it believed the problem was of a similar nature.

The pole-sitting McLaren of Inception Racing was the British manufacturer's fastest car and sole finisher, albeit six laps adrift. Its delay was caused by a radiator change after Bronze driver, Brendan Iribe, bailed out from one of the Mulsanne Straight chicanes in wet conditions and struck one of the tyre barriers designed to slow vehicles that cut the corner.

A spectacular rollover claimed Heart of Racing's Aston Martin Vantage GT3 EVO, whilst the no.54 AF Corse Ferrari 296 GT3 crashed hard into the barriers at Dunlop, making it the first LMGT3 to exit the race.

JMW Motorsport's Ferrari looked strong on Saturday but suddenly ground to a halt with a loss of fuel pressure in hour 10. The surviving Ferrari finished sixth, behind a Lamborghini Huracan GT3 EVO2 and a pair of Ford Mustang GT3s that held up better than expected on their Le Mans debut.

Detaching diffusers afflicted the new Ford's early races, but the manufacturer worked with the FIA to introduce a fix. A new mid-mounting point for the diffuser was created, in between the original side-mounting points. Ford also fitted two extra latches to secure the deck lid, which was coming undone from its fastening pins due to air disturbance in close-quarters racing. With those changes in place, the Proton team running the Fords could worry less about sudden issues and focus more on car set-up.

Chevrolet, on the other hand, had a poor race with its cars that were making their debut at the race this year and they finished outside the top ten. One of the new Corvette Z06 GT3.Rs was blighted by a power control unit glitch. The other ran slightly better but still battled a pull away clutch issue and finished three laps down.

The Lexus RC F GT3 had decent pace and was strong in the high-speed corners, but Akkodis ASP's best car ended up two laps down after its bonnet popped loose.

New dawn

There were differences in how the LMGT3 race played out compared to previous editions with GTE cars. For one, the cars were subject to a different BoP system. The previous-generation GTEs had their powertrains balanced through air restrictor diameters and turbo boost pressure numbers that were made explicit in the BoP table.

All brands were capable of lapping within one per cent of the winner on average, and even that number can be expected to reduce

In the new LMGT3 class, cars are given a maximum power output and energy allowance per stint, measured by driveshaft-mounted torque sensors. Naturally aspirated GT3 cars still use air restrictors, but there is flexibility in their tuning as long as the power limit and torque curves are respected.

The energy rules reduced stint lengths at Le Mans to around 40 minutes, as opposed to the hour-long stints that GTE managed. Teams were therefore expecting to make more pit stops than in the GTE days, but the long safety car periods meant energy consumption was low at those times. Consequently, the winning Porsche made only 28 pit stops, compared to 24 of last year's GTE-Am victor.

Pace-wise, the fastest LMGT3 race lap of 3m 57.429s, set by Conrad Laursen in a Ferrari, was 7.722 seconds slower than the GTE-Am record, while the average top speed of the eight GT3s in Hyperpole was 16.51km/h down on GTE-Am last year. Despite being slower, the GT3s were reasonably close. All brands were capable of lapping within one per cent of the winner on average and even that number can be expected to reduce as the BoP is further refined. GT3 looked a natural fit at Le Mans and a worthy successor to GTE.

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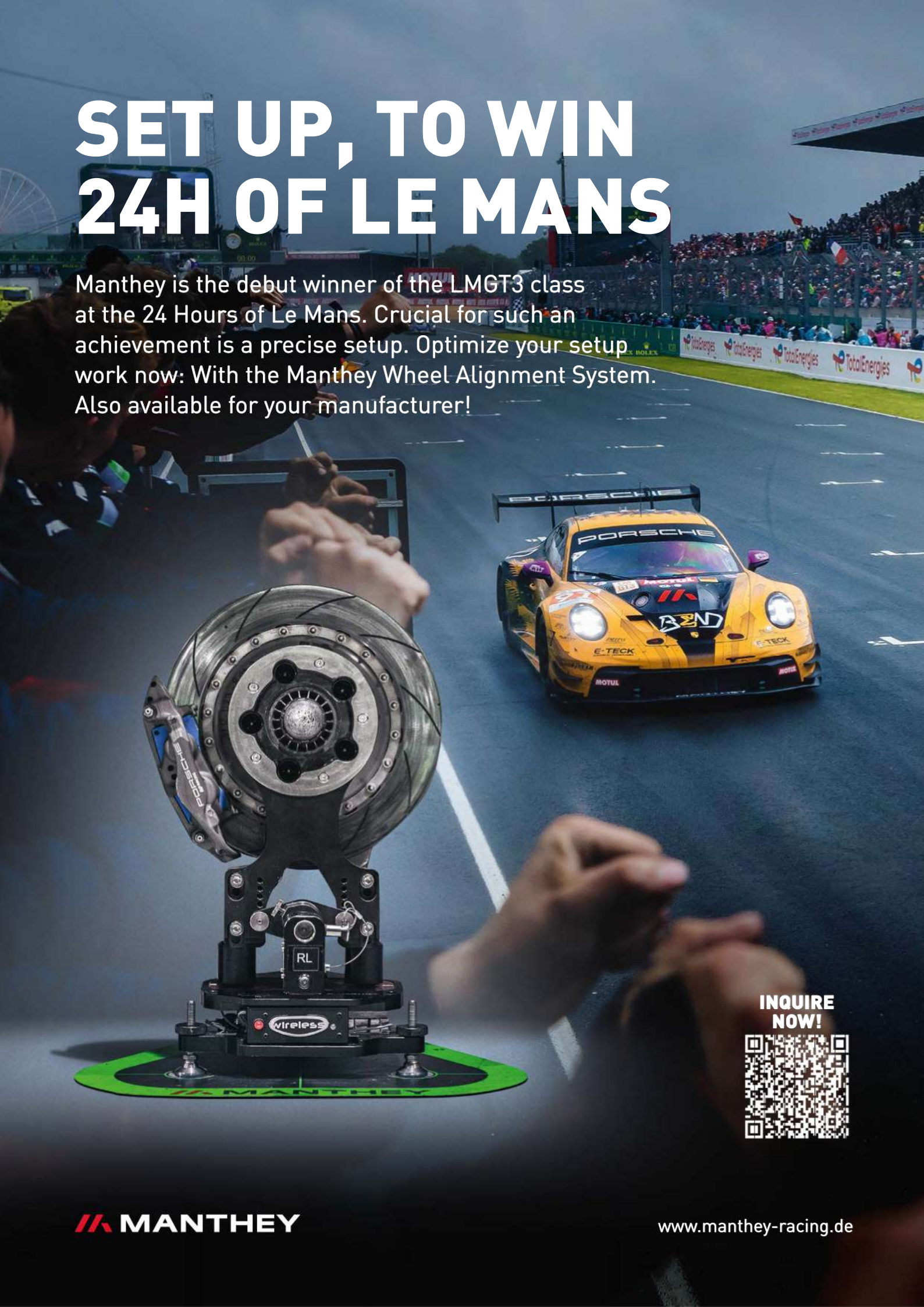

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Clean slate

New LMP2 cars have been delayed until 2028 and the technical blueprint has been re-set. Racecar *explains the situation*

By DANIEL LLOYD

LMP2 has become a de facto single-make class for ORECA 07s and the next tender is expected to pick only one chassis builder

LMP2 is one of sportscar racing's longest serving categories, and has evolved greatly since it first appeared at the 24 Hours of Le Mans two decades ago. Its current regulation cycle started in 2017, when it went from being an open formula for a wide range of chassis and engine manufacturers to a cost-controlled platform for closed-cockpit prototypes.

Four companies – Dallara, Ligier, ORECA and Riley (now Multimatic) – were selected to build chassis and Gibson Technology became the exclusive engine supplier. Over time, the teams buying and running the cars determined the ORECA 07 to be the pick of the bunch, which inadvertently turned LMP2 into a de facto single-make category as other constructors struggled to gain a foothold.

ORECA has now produced 127 LMP2 cars, which have dominated grids in the IMSA SportsCar Championship, European Le Mans Series, Asian Le Mans Series and FIA World Endurance Championship, until the latter axed its LMP2 class for this year.

Although it has been a resounding commercial success for ORECA, and has produced close racing, LMP2 has not delivered on the chassis variety the 2017 rules sought to preserve in a watered down form.

Delayed regulations

New regulations have been in the pipeline for several years now as Le Mans organiser, the ACO, seeks to preserve a category it deems an important part of the endurance racing pyramid. LMP2 sits above the cheaper LMP3 platform and has served as an effective proving ground for many teams and drivers now racing in the Hypercar and GTP classes.

Initially, the plan was for new LMP2 cars to arrive in 2024. They were to be based on the LMDh chassis that have been built by the four licensed LMP2 constructors. The technical connection between LMP2 and the top class stems from IMSA's DPi regulations of 2017-2022, which gave car companies a chance to go racing on a lower budget by integrating their own engine and bodywork around a pre-built LMP2 chassis.

However, when LMDh replaced DPi in 2023, the opposite approach was taken, with the next generation LMP2 cars based on the LMDh package instead, just without the complicated spec hybrid system.

Successive announcements in 2022 pushed the start date for the new LMP2 cars back to 2025, and then 2026, as the rules and costs were figured out. One of the proposals at that time was to introduce an 'Adjustment of Performance' (AoP) system to help balance the four different LMP2 cars and avoid a repeat of ORECA's recent dominance.

Then, on the eve of this year's Le Mans race, the FIA and ACO announced the new LMP2 rules would be delayed, again, to 2028. They also confirmed the technical blueprint would effectively be re-set; the next generation LMP2 will have a new, lighter chassis.

Single chassis

It is understood that tender processes for a single chassis and single engine supplier are currently being prepared, although it is unclear when applications will open.

Having a single chassis would be a huge shift for the category, which has always allowed, and encouraged, different car builders. It would also remove the need for a performance balancing system.

The new LMP2 engine will be smaller than today's 4.2-litre, naturally aspirated, Gibson V8. That engine is capable of producing up to 600bhp, although it has been de-tuned to varying degrees, depending on the requirements of different series.

Dallara, which developed the P217 under the 2017 regulations, is frustrated at the new rules being delayed again

Although it wasn't explicitly stated by the organisers during their recent announcement at Le Mans, revealing plans for a new chassis and engine means the original strategy – for the next breed of LMP2 to be derived from the LMDh spine – has been thrown out.

ACO competition director, Thierry Bouvet, later cited 'wrong timing and cost' as two reasons for abandoning the LMDh connection. When that idea was conceived, it was thought LMP2 would still be part of the WEC in the future. However, the popularity of Hypercar and LMGT3, both attracting nine manufacturers, drove the WEC to drop its LMP2 class at the end of last year. When that decision was made, the technical direction of LMP2 shifted to a clean-sheet design.

A matter of cost

Bouvet's mention of cost, meanwhile, refers to money spent by the teams. Many of them felt an LMP2 chassis derived from LMDh would be heavier, more complicated and more expensive than what they currently have. This instigated the change of direction towards lighter, more efficient cars.

Furthermore, sticking to the current rules until the end of 2027 gives the teams clarity on how long they can continue to use their existing ORECA 07 chassis.

On the other hand, discarding the LMDh technical link has impacted the existing LMP2 chassis constructors.

Dallara representative, Max Angelelli, acknowledged the Italian company had already done 'a lot of work' on its version of the next gen' LMP2 car (the constructor built its P217 car to the 2017 regulations and a handful of teams chose to run it, though one hasn't been seen in a major series since 2021). The company has invested substantial resources into the vehicle's development, including wind tunnel testing, and courting teams for potential customer deals. Dallara will now need to wait a further two years for clarity, during which time LMP2 is poised to continue with all-ORECA grids.

'That work started in 2020,' said Angelelli, of Dallara's LMDh-based LMP2 concept.

'Originally, [it used] the LMDh spine for LMP2 and [there was a] price cap on the spine. It was all connected. Now there is this stop and pause. We need to get together again as a constructors' group, with the sanctioning body, and re-think on the new car.'

Ligier Automotive president, Jacques Nicolet, declined to comment on whether the further delay would negatively impact his company, which was the most recent non-ORECA constructor seen at Le Mans, last year.

'We wait now to have a new configuration to re-start work on it,' was all Nicolet was prepared to say. 'It's one direction and, if it's the direction the ACO take, we support it.'

Power play

The change of plan has also affected current LMP2 engine supplier, Gibson. The British company was awarded the tender to produce the next generation, 4.2-litre, V8 engine from 2026 until 2030. But the start of a new engine tender process for the 2028 car design means Gibson would need to re-apply for the contract it thought it had already won.

Again, at time of writing it is unclear what the engine tender requirements will be, other than a reduced cubic capacity. It remains to be seen if LMP2 will remain naturally aspirated or switch to turbochargers. Like many of the other stakeholders, Gibson is currently waiting for more information.

Elsewhere in the paddock, there was a definite air of positivity, notably from Lola Cars, the revived British constructor that is returning to motorsport as a Formula E powertrain supplier next year, but also with Le Mans in its sights.

'We will have time to make the right decision on the technical content. ORECA will be there to succeed again'

Rémi Taffin, motorsport director at ORECA Group

LMP2, which sprung out from LMP675 as the second-tier class in 2004, has evolved significantly over the years since

Its motorsport director, Mark Preston, was at this year's race and voiced support for the rule re-set. Lola has plenty of LMP2 heritage and was a prolific constructor for several years until the number of permitted chassis was limited to four. However, if the category moves towards a single chassis supply, as expected, it will be even harder for a newcomer, or returnee such as Lola, to make its mark.

Pole position

Perhaps unsurprisingly, ORECA appeared to be the happiest party after the ACO and FIA's announcement. Firstly, extending the current regulations cycle until the end of 2027 is a positive for the French constructor because it prolongs its current monopoly.

'I think we can say it's good news to us, but I'd rather say it's good news for LMP2, because we have these cars ready,' said ORECA Group motorsport director, Rémi Taffin. 'They are performant and reliable. We know our customers are happy to race it.

'We want to make sure we can be alongside the ACO and FIA to determine what's going to be the next [LMP2 rules]. We take the time – obviously not too much – to [determine] what is going to arrive in 2028. We have maybe a year in front of us to look after that. But there is some direction.'

Taffin did acknowledge that time spent on converting the ORECA LMDh base, which is used by the Alpine A424 and the Acura ARX-06, had been lost due to the LMP2 rules re-set, but was enthusiastic about potentially designing a new car to replace the 07.

'I don't see it as throwing away [time],' he said. 'It's like an investment. It's also normal to not have the right answer right at the beginning. We should not be shy to go for a new [chassis]. We will have time to make the right decision on the technical content. ORECA will be there to succeed again.'

Although a clearly confident Taffin indicates there is time for the organisers to define the technical details, at present it is unclear when that information will be ready. The rule makers are clearly not yet prepared to divulge much more information than what was announced at Le Mans.

However, what they are clear about is the importance of LMP2 to sportscar racing. As it was being squeezed out of the WEC, the ACO promised to reserve at least 15 grid spots for the class on the Le Mans grid, which it honoured this year. During the 2028 roadmap announcement, ACO president, Pierre Fillon, described LMP2 as a 'key category… that we must absolutely protect'.

Considering the dramatic rises and falls that can happen in a manufacturer-led top category, the organisers know it is crucial to have a strong, second-tier prototype class to maintain the overall health of their sport.

Euro fighters

Japo Santos

The NASCAR Euro Series was founded by Jérôme Galpin, director of Team FJ, and has become a staple of European racing

Flying the flag for NASCAR across the pond, the well-established Euro Series aims to prepare drivers for the big leagues

By DANIEL LLOYD

There's a popular internet meme where a child asks his mother if they can have a certain fast food for dinner and she replies, 'We have that at home', accompanied by a photo of a sorry-looking microwaved burger. A motorsport version might go something like, 'Mum, can we have NASCAR?', to which she replies: 'We have NASCAR at home', accompanied by a shot of a Euro Series first-corner pile up.

Admittedly, that was the uninformed, and perhaps rather unfair, impression this author had of Europe's FIA-sanctioned stock car series before attending the recent British round, held at the Brands Hatch Indy circuit as part of the American SpeedFest event.

The NASCAR Euro Series is a highly competitive championship now in its 16th season. Far from being a poor relation to its American cousin, it has its own identity and sees well-drilled teams vying for the title.

The V8-powered cars are loud, brash and require skill behind the wheel because they can be a handful through the corners.

At Brands Hatch, drivers take different angles through Clark Curve and feather their way onto the Brabham Straight without the luxury of traction control to aid them.

Circuit challenge

The European grid is a burst of colour and sound. Close to 30 brightly liveried cars, powered by a thunderous spec engine, pound around at different cornering angles in spectacular fashion. Whilst many of the parts are tightly controlled by the series to prevent cost escalation, there are still opportunities for teams to engineer their way to success. The variety of circuits on the schedule, owing to Europe's paucity of ovals large enough for this kind of car, adds to the set-up challenge.

There has long been an appetite for American-style stock car racing in Europe. ASCAR operated in the 2000s, mainly using the defunct Rockingham Motor Speedway in the UK, but for well over a decade the pinnacle has been the Euro Series.

Founded by Jérôme and Anne Galpin in 2008 as the Racecar Series, it was brought under the NASCAR umbrella in 2012, making it one of four licensed NASCAR international series, the others being in Canada, Mexico and Brazil. Each has slightly different technical specifications and suppliers.

In Europe, the beating heart is a 5.7-litre, 604 crate V8 from GM Performance, the same as is used extensively in American Late Model racing. The rear-wheel-drive cars produce around 400bhp and weigh 1225kg without the driver, with an approximate 60 / 40 weight distribution in favour of the front, where the engine is positioned.

Power is transferred to the wheels through a four-speed, dog-leg manual gearbox from G-Force Transmissions in Pennsylvania.

The chassis is a steel tube frame design that can trace its lineage to a chassis developed by McColl Racing for cars competing in the Canadian NASCAR series. The blueprint of that chassis was then picked up by French company, Team FJ. The Blois-based organisation established the Euro Series and co-runs it with NASCAR, whilst also being responsible for assembling the cars that are purchased by the teams.

Whilst many of the parts are tightly controlled by the series to prevent cost escalation, there are still opportunities for teams to engineer their way to success

Japo Santos

All cars use a GM Performance 604 crate engine, an off-the-shelf V8 package that makes 550Nm of torque at 4600rpm

'Our philosophy is to maintain control of the teams and let teams have equal purchasing power of those parts. They don't have to pay for extra manpower, software or simulators to compete at a higher level in this championship'

Joe Balash, NASCAR Euro Series sporting and technical director

'It had to go through a whole approval process here in Europe, to make sure the FIA standards were applied to it,' says NASCAR Euro Series sporting and technical director, Joe Balash. 'It's a fully homologated car to FIA standard. A number of updates were brought in because of that. For example, we use a crash box in the front of the car, and we've got some extra reinforcement in the rollcage.'

Budget conscious

The standard brake package from Brembo consists of four-piston, monobloc calipers and 330mm vented discs. Suspension parts are also standardised and come from the French supplier, ALP Racing.

The chassis is shrouded in glass fibre bodywork, which differs depending on the car company teams wish to represent. Ford Mustangs, Chevrolet Camaros and Toyota Camrys make up the current grid, in keeping with popular model lines in the US.

'We want teams to be able to come to this series with a reasonable budget and not have to outspend somebody to win races,' explains Balash. 'At the upper levels on the American side, before they went to the new [Next Gen] car, anybody could go to Mooresville and buy every part to build a car. But if you wanted to win races, you had to *build* every part. That makes a considerable difference to budget.

'Our philosophy is to maintain control of the teams and let teams have equal purchasing power of those parts. They don't have to pay for extra manpower, software or simulators to compete at a higher level in this championship.'

Walking the paddock at Brands Hatch, some teams clearly have bigger budgets than others. Some are running multiple cars, and the largest trailers are up there with the leading outfits in any other European race series. But there are also smaller operations with fewer resources, so it's important for the organisers to keep things in check to ensure close competition and healthy grids.

'Teams will always find ways to spend budget, but we try to control the things that affect performance,' says Balash. 'We're running a sealed engine, so teams aren't allowed to go in and tinker with the engine internals to gain performance advantages. We seal the carburettor, ignition system and shock absorbers for the same reason. We also run spec gear sets in the transmission.'

Engineering gains

Despite the large number of spec components, there are some opportunities to make gains through clever set-up. The rear of the car is largely fixed; the spoiler angle is determined by the series at 70 degrees + / – two per cent, while the camber and toe are also set in stone. The Watt's linkage on the rear axle, however, as well as the trailing and upper links, are all adjustable.

'We control the angle on the back of the car, and the nose height,' continues Balash. 'We also control the frame heights. If we didn't do that, the team would have the cars slammed on the ground to lower the centre of gravity. We control the basics.'

There is greater tolerance on tweaks to the front end, which can be used to refine the car's handling characteristics. Teams may alter the stiffness of springs and dampers, or adjust suspension settings such as camber, toe and caster on the front.

'Obviously, if you compare the adjustment with a single-seater Formula 3, or something like that, you don't have so many parameters to work from,' says Carmelo Scoglio, engineer for CAAL Racing, an Italian team that is one of the most experienced in the paddock. 'But, in this case, the parameters in which you can work are enough to modify the car's behaviour completely from one track to another.'

Nina Weinbrenner

Limited downforce, no traction control and H-pattern shifters makes the Euro Series car fun to watch and tricky to drive

That adjustability has increased even further this year, with the introduction of an 'Evo' upgrade kit. It consists of a new spring package and mandatory front spindles (stub axles) to make the car more agile in corners, and to give teams some more tuning options. Gradually, the organisers have eked out more ways in which the teams can play with the handling, without letting them run wild.

Evo upgrades

'Some years ago, we had dampers with only two parameters of movement – bump and rebound,' recalls Scoglio. 'Now, for about three years, we have bump in high and low frequency, and the same for rebound. In previous years, we had less parameters on which we could work.'

To this Balash adds; 'We have a fairly decent array of spring range for the car. We opened it up more this year, so they can choose different spring rates in the front and rear. Years ago, when the series first started, you had a single set of front springs and back springs. Now, you have choice.

'We also have a tender on the top that changes the combination, so there are a lot more adjustments [available] now.

'The shock package evolved over time, too. We now have adjustable shocks on the car [and] compression rebound adjustment so they can be tuned to a driver's liking, or needs.'

All this adds to the Euro Series' exciting on-track spectacle of drivers taking different lines through the same corner.

'The line you run, the angle you're going to take in that corner, how deep you're going to drive it or how soon you're going to let off, is all going to make the suspension work differently,' notes Balash. 'This is where the driver and the engineer really have to communicate on how to set the car up.'

Driver aids

The Evo kit also includes a speed limiter for pit lane driving and Full Course Yellow periods. Additionally, driver comfort has been taken into consideration with a number of additional features that are due to arrive soon, though supply chain hold ups have delayed their planned introduction.

'We added an air vent in the top of the roof to help the drivers,' says Balash. 'We were seeing some heat transfer from the headers into the chassis, which makes the interior of the car a little warmer, so we added the vent to improve airflow inside the car.

'When we configure the louvre supply, that will vent heat from under the car early, rather than radiating it back underneath.

'Because we have rules on noise levels at the tracks we run at, we have to use mufflers and that generates a little extra heat that transfers into the chassis. Moving that air gives the driver a fresher feel.'

Stephane Azemard

The oval track at Venray (pictured in 2019) lets the series connect with its American roots and offers a different set-up challenge

Japo Santos

Ride height is adjustable at the front but must be in accordance with parameters provided by the series

This year, the Euro Series is visiting the road courses at Valencia, Vallelunga, Brands Hatch Indy, Most, Oschersleben and Zolder. However, the jewel in the crown is Venray, the only oval circuit on the calendar. The 0.88km track in The Netherlands hosted the series from 2015-'17, and again in 2019, but then dropped away during the Covid pandemic before making a most welcome return to the calendar this year.

Previously, the Euro Series held an oval race at Tours in France. More accurately, it raced in the car park of an exhibition centre in Tours, with banked turns at each end, creating one of the most unique racetracks in Europe.

'Years ago, when the series first started, you had a single set of front springs and back springs. Now you have choice'

Joe Balash

Tours last held a Euro Series round in 2018, so Venray is now carrying the torch for 'proper' NASCAR racing on this side of the Atlantic.

Car set-up for the 100-lap race (or 70 laps for the second-tier Euro 2 series) at Venray is, naturally, very different to the other tracks, which played into the hands of the teams and drivers that had raced there before. There is no special car package deployed for this track; the European NASCAR must be able to cope with the oval as well as the road courses.

'Normally, you have more or less the same ride height per axle,' says Scoglio. 'On the front and the rear, it's the same right and left. In the case [of Venray], you have different values on the front and rear, right and left. On the external wheel, you have a negative camber, but a positive one on the internal wheel because the car is on the bank. The external one needs a little bit more camber to have a complete tyre on the ground. On the other side, you have to think in the opposite way.'

Scoglio suggests a baseline front camber angle for Venray is around eight degrees. The wheels are still noticeably cambered for road

Japo Santos

Team FJ in France assembles the chassis, which is homologated as EuroNASCAR-RC01 and has been used since 2009

courses, set at around five or six degrees, depending on how exactly the individual team wants to set their car up.

Racing on an oval, albeit a small one, brings differences to the racing, too. Road courses tend to invite drivers into single file after a handful of corners, whereas at Venray they might be running for several laps adjacent to a competitor. Having that variety is part of the allure of a series where the technical regulations are tight.

American connection

Being part of the NASCAR organisation means the Euro Series is an ambassador for this style of racing 'across the pond'.

'There is a tremendous level of support and conversation between our business in Europe and the NASCAR management on the other side,' says Balash. 'They are super supportive of everything that's going on in the Euro Series. We all want to promote that brand of NASCAR racing as it's what makes us different. We don't want to just offer the same style of racing you get in the US. It is valuable having that ability to share things, to grow the sport both ways.'

The Euro Series has succeeded in being an established, healthy competition on its own continent, but it has found the goal of cross-pollinating drivers into the US to be a challenge. The 2021 European champion, Loris Hezemans, made five NASCAR Cup Series appearances the following year, but has not made a lasting breakthrough. Similarly, Alon Day, the most successful driver in Euro Series history with four titles to his name, has made infrequent Stateside appearances.

While there hasn't been as much east-west movement as the Euro Series might perhaps like, it hopes more drivers will look to venture in the opposite direction in the future.

The Euro Series' focus on road courses is a particular draw for American drivers who want to learn some tricks they can take home. For example, 23-year-old Californian racer, Ryan Vargas, is competing in the Euro Series' top Pro division this year, alongside occasional outings in NASCAR's second tier.

'We would also like to be a development series for young drivers in the US who need training in road racing,' says Balash. 'There is a lot [of American road racing] but we offer many opportunities to learn it at a very high level. We also want US team involvement. There is a tremendous opportunity to have those conversations and share ideas on all levels, not only technical but also business. We want to be that platform to help develop new drivers.'

Injected future?

Looking to the future on the technology front, the Euro Series is happy with its car concept because it provides cost-effective racing and a decent approximation of the sights and sounds you would expect from a US event. Certainly, there aren't any plans to adopt hybrid or electric power, unless the series is forced to by global regulations.

More likely are changes in the way the ICE is managed. For example, the series currently uses a single four-barrel carburettor, but Balash says he is keen to explore a switch to fuel injection. Balash had prior experience of exactly this during his time as vice president of operations at the American Speed Association, which championed the switch to fuel-injected stock cars.

'We would also like to be a development series for young drivers in the US who need training in road racing'

Joe Balash

Cars run on a set of 330 / 700 R15 slick tyres from Hoosier, which replaced General Tire as the NASCAR Euro Series supplier in 2021

Japo Santos

With a four-speed manual gearbox and no driver aids, racing in the Euro Series is hard work, but that's part of its draw for competitors

'There are opportunities to go to fuel injection that aren't super expensive,' Balash suggests. 'There are other things down the path that we could look at, to bring the car closer to current technology and keep the costs down. You take the carburettor off, put the fuel injected throttle body where the carburettor was, hook up a little wiring, add an additional box for control and make sure you have the proper fuel pressure going to it. We don't have to re-invent the whole engine to make that change.

'Those are things that have to be tested and approved before they can be implemented, but we have a list of things we want to look at, to continue to enhance.'

The organisers are sensitive to making changes that are too drastic, as they seek to keep things as cheap and straightforward as possible. For a series that makes so much noise on track, it has managed to get by in the background with little revolution or fuss. But its longevity and enduring popularity among teams prove it has earned its place as a mainstay of the European racing scene.

Learning in motion: Bath Automotive MSc courses

What was the first car you ever drove? What car will you be driving in 2030? Will people still drive cars at all in 2050? The last car built on earth will surely be a sports car is a quote attributed to Ferry Porsche. But if you had the opportunity to design a car, what features would it possess and what would it look like? Where would you drive it and who would you want to take with you?

At the University of Bath we've designed our suite of automotive MSc courses to help a new generation of professionals tackle some of the worldwide environmental and societal challenges that characterise our times. We've incorporated some of the best attributes of the automotive sector, like finding practical routes to bring about positive change at pace.

If the car can be seen as an embodiment of an innate human thirst for adventure, exploration and new experience, it should be no surprise that these core attributes have influenced how we deliver our courses. They feature:

- practical and immersive lab sessions
- collaborative tutorial and problem-based learning workshops
- interaction with our IAAPS research community

This is all backed up by lecture-based exploration of theory, involving worked examples. Collectively, a fertile environment for inquiring minds.

Whole world challenges

One positive outcome that can happen when global challenges arise is the growth and strengthening of worldwide communities. Motivated by a desire, or indeed need, to find practical and sustainable solutions, they're brought together by mutual concerns to collaborate on issues. Can the fast-paced automotive sector help accelerate the potential benefits of connected and sustainable cities, mobility networks and lifestyles?

Currently, around 1.4 billion road vehicles contribute to around 16 per cent of all worldwide CO_2 emissions associated with human industrial activity (anthropogenic). At the same time, the overall level of CO_2 in the earth's atmosphere is intrinsically linked to the climate characteristics we experience throughout our lives. The international automotive industry therefore has an important role to play in tackling CO_2 emissions, in conjunction with wider mitigating strategies, and in harmony with policy makers such as the Intergovernmental Panel on Climate Change (IPCC), which aims to advance knowledge related to climate change resulting from human activity.

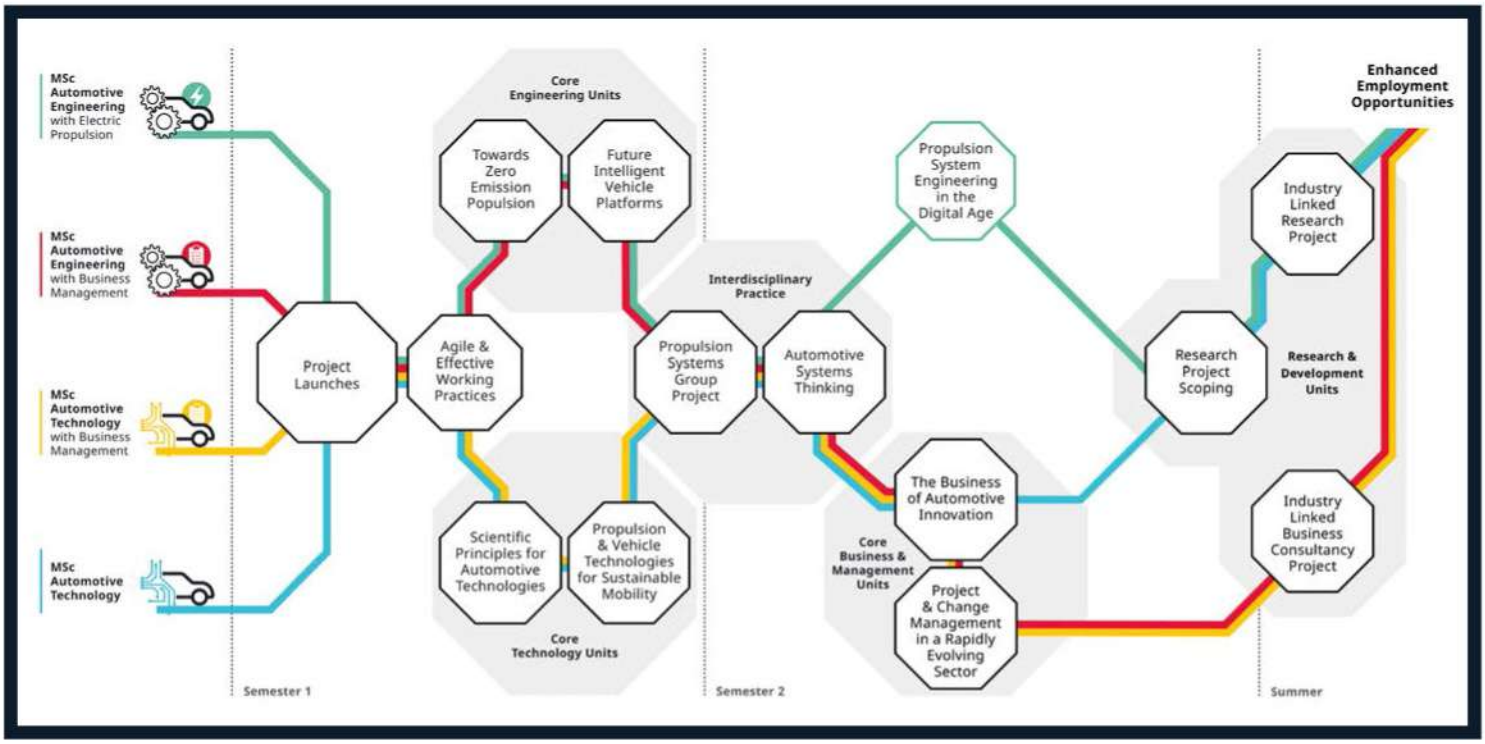
The tailpipes of vehicles powered by ICEs emit airborne pollution in the form of particulates. As do the brakes and tyres of all vehicles, to varying extents. We can treat this separately to the problem of CO_2 emissions but, as a human health issue, it still poses significant concern.

That the automotive sector has an estimated financial worth of $2 trillion a year indicates how many lives are affected by vehicles and road transport. It also suggests that options for action are within financial reach.

Ongoing research

Ongoing research is finding ways to accurately reveal which aspects of CO_2 emission-driven climate characteristics are related to anthropogenic activity, and which are related to natural mechanisms. This will take time and, while it does, there is an opportunity for the automotive industry to do what it's good at – adapting to deliver measurably improved and affordable outcomes.

New research and development in propulsion systems technologies could have real potential for reduction in CO_2 emissions. It also aligns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Enhanced Employment Opportunities
Industry Linked Research Project
Research & Development Units
Industry Linked Business Consultancy Project
Semester 1
Semester 2
Summer

with the UN's 17 sustainable development goals (SDGs) and their three-pillar definition of sustainability (environmental, societal, economic). It also provides a route to re-imagined industry, delivering new transport and mobility technologies and services.

The history of the automobile itself also shows potential exists for the fast-moving automotive sector to pave the way for technological advancements, helping navigate routes other sectors can join, or follow, and bringing benefits to the wider society. If these efforts lead to sustainable, low-carbon mobility practices, or 'low entropy lifestyles', they are in tune with public interest, and a move towards a cleaner, brighter future.

Preparing for the challenges of a brave new automotive industry requires a well-tailored approach to education. So, in our four automotive degrees we address key topics, including:

- low-carbon propulsion technologies (from component to vehicle system level)
- vehicle body design packaging to accommodate new propulsion systems from a clean sheet approach
- aerodynamic bodywork incorporating low-drag external surfaces and internal airflows for heat flow management
- suspension systems to support the new payload and weight distribution characteristics
- connected vehicles (long since untethered from horses, but now digitally tethered for data sharing and congestion management)
- artificial intelligence (AI) as an engineering challenge and opportunity, from both technical and ethical perspectives
- agile and ethical professional working practices
- project and change management
- innovative automotive business practices

At University of Bath we offer four automotive MSc courses, designed to suit the experiences and aspirations of a wide range of applicants who will be needed for the next generation of the automotive industry

Each of our automotive MSc courses has its own unique flavour, but they are designed to work together as a whole. We bring all four cohorts together for group-based teaching units, and this integrated approach nurtures community cross-course interaction and prepares students for industry practice.

Course features

Semester one focuses on structured learning in immersive environments. An annual course theme related to future transport and mobility is set at a course launch meeting. You'll then explore the fundamentals of propulsion and the future purpose of the car. Best practices for AI as a learning aid are shared.

Semester two focuses on application and consolidation of knowledge and understanding, with tutor guidance. You'll work on group projects, including whole vehicle performance modelling using industry-standard tools, and Life Cycle Assessment (LCA). You'll explore systems thinking and specialise in technical or business management topics.

Semester three (summer project period) focuses on student-led innovation. You'll undertake an industry-linked project ('mini-placement' experience) with either engineering technology or business management themes. You'll work on live projects and applied engineering challenges, and learn personal professional development skills, but with a friendly campus support network.

Let past successes inspire you to engineer the future

The city of Bath is a beautiful world UNESCO heritage site, with a rich cultural history. It's a natural fountain of inspiration, which allows us to take the best of long-standing fundamental principles and combine them with modern best practices in digital and physical learning, to produce a unique approach to science-informed practical problem solving. This is how we journey towards cleaner and more sustainable future mobility and transport systems and, by the same token, healthy human lifestyles, too.

Drive on!

Please get in touch if you'd like to find out more about our Automotive MSc courses, and the timely career opportunities of a technology-neutral approach to the task of engineering sustainable mobility.

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Scan the QR code to Book a quick chat with an academic and find out more.
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At 90, the Vintage and Sports Car Club (VSCC) is almost as old as some of the cars that compete in its events. It's also old enough to be eligible to enter some of its own races! Joking aside, the organisation has done much in that time to keep historic racecars alive and kicking.

These days, much of the VSCC's activity is based around vehicles built in the decade the organisation was founded (the 1930s) and the decade before that. Or, to put a suitably historical boundary on it, cars built before the Second World War, also known as pre-war.

The club organises a selection of race meetings, sprints and hillclimbs in the UK and, such is the popularity of its racing, a small industry has grown up around racecars built before 1939, with professional race teams and many marque specialists involved.

People like Simon Blakeney-Edwards, for instance, who, as well as being president of the VSCC, also heads Edwards Motorsport. His eponymous company builds, prepares and runs pre-war racers, with a particular expertise in Frazer Nash machinery. Companies like his not only restore and keep cars going but also, inevitably, given the nature of motorsport, seek to improve them, especially when it comes to the engines.

'We use modern technology for the engine designs, internally, with the camshafts, gas flowing etc. Hence, all the pre-war cars are going an awful lot quicker than they did in period,' says Blakeney-Edwards.

'A typical Frazer Nash Meadows engine, which was producing about 50bhp in period, we're now seeing 120, even 130bhp out of it.'

Old and the new

While the engines can benefit greatly from a modern design approach, and by having improved pistons and superchargers, thanks to more accurate clearances, other parts of the car, such as the chassis and the bodies, still rely on old fashioned craftmanship.

'The chassis are usually steel frame,' continues Blakeney-Edwards, 'but the body, which is a separate entity because there was nothing like a monocoque back then, were traditionally an ash frame covered in aluminium or fabric. Making the ash frame, then doing all the panel beating, is very time consuming.'

On the upside, sourcing the raw materials required for this sort of work is not so much of a problem. 'For things like the chassis work, we use regular steel. But then if you're making back axles, or driveshafts, you'll be using EN32T, or something like that. It all depends on the application,' notes Blakeney-Edwards.

Obviously, steel was a key feature of suspension systems in the 1930s as well. While coil springs were around back then, leaf springs were far more common. And, unless you own a Toyota Land Cruiser Troopy, these are rarely an off-the-shelf item today.

'There are still companies around that will make you new leaf springs,' says David Morris of ERA specialist, David Morris Race Preparation, 'but you're probably in for some months of waiting.

'The other problem is all the steel they used when the cars were built was in imperial sizes. Nowadays, a spring specialist will say "we've only got metric", so they then have to get the steel machined to the right size before they can set it, temper it and everything else. So that takes additional time and puts the cost up a bit.'

The VSCC is 90 this year. This picture shows two pre-war ERAs sandwiching a rare Alta during the club's 2024 season-opening meeting at Silverstone, UK

Ian Wagstaff

A fine vintage

Engineering any car to a good standard is tough, but how about one that's nearly 100 years old? Racecar *visited the Vintage and Sports Car Club's 90th anniversary event at Silverstone to find out*

By MIKE BRESLIN

Measurement systems are not the only fundamental changes since the 1930s. Some materials that were used back then are simply no longer viable, or available. This is particularly the case with brakes.

'The modern materials we use today aren't as good as the materials they used in period, because they used asbestos,' says Blakeney-Edwards. 'It was a very, *very* grippy material. Obviously, we're not allowed to use that anymore… We've compensated by using different materials on the drums, so you can get the brakes to work very well. They're not as good as on your modern car, obviously, but they're certainly sufficient.'

Fluid situation

Fuel is another thing that is much better now than it was 90 years ago.

'Back in the day, your normal fuel was not very good at all,' says Blakeney-Edwards, 'so with the racing fuels, they mixed in all sorts of things. These days, we just use regular 99 or 97 [octane] in our cars, and it works very well.'

VSCC competitors in some disciplines have used sustainable Coryton Sustain 80 fuel this year too, but cars such as the ERAs require more specialist potions, in their case methanol. 'They were designed to run on that,' says Morris. 'Methanol is a terrific fuel for cooling engines as well; it keeps the pistons cooler, though they do need the alcohol to make them run properly.'

Another thing that has improved over time is the quality of the tyres but, with the tall wheels and the desire for a crossply construction, these are now quite specialised.

'They're an R5,' says Morris of the rubber on the ERAs. 'Dunlop still makes them, fortunately, and while they look similar, they are probably a far superior tyre to whatever they had pre-war.'

So, while fuel and race rubber might be relatively easy to source, what can be much harder to find is drawings to work from.

'Certain factories, like Riley for example, were bombed out during the war, so they lost an awful lot of drawings and information,' says Blakeney-Edwards.

Ian Baxter, who runs his own Alta 61, says there are no drawings at all in existence for his car, so 'everything has to be reverse engineered'. Even if you do have the blueprints, there is still the problem of having parts made, particularly some of the larger engine components.

Engine building

'Arguably, the biggest challenge is making engines – casting crankcases, blocks, cylinder heads,' says Blakeney-Edwards. 'We'll get patterns made, then send them off to foundries to cast them, and then use a CNC machine shop with four-axis [mills] to machine them. It just wouldn't be financially viable to do the whole process in-house because of all the machinery you need.'

Fortunately, companies to do this kind of work still exist in the UK, but they're not exactly abundant.

'For something like a crankshaft, or conrods, you have to go to a specialist, and there aren't that many people that will make them. You're limited to maybe three companies in the UK,' confirms Morris.

'The biggest challenge now is the time it takes to make them. Before Covid, it might take six weeks, but now you're probably looking at six months, or more. For a lot of things now, you're almost on a year lead time.

'Maybe these specialist companies are just snowed under because there aren't as many people doing this type of work these days,' Morris adds. 'That means there's a bigger demand placed on those that do.

Vintage gear

There is not much to differentiate what goes on in a VSCC paddock from that of any other race meeting. Except you will often see cars jacked up at the rear with their back wheels spinning impotently in the air. This is because of the pre-selector gearboxes, which were quite popular in the 1930s and are used in both the ERA and Alta highlighted in this feature.

As the name suggests, these allow a gear to be pre-selected on the approach to a corner, the driver then simply depressing the clutch pedal to engage it when it's needed.

'When you get used to one of these, you can see why they used them,' says Baxter. 'They are so quick, and you never miss a gear.'

'If you're going down the straight in top gear and you're going to need third for the next corner, you pre-select third,' explains Morris. 'You can then take that gear mid-corner, without having to take your hands off the wheel. And because these cars are quite skittish, sliding around a bit, that extra control can be a big advantage sometimes.'

The big disadvantage, however, is the weight and complexity of such gearboxes, and also the loss of power through transmission drag.

'They're heavy, and it takes a lot of power out of the engine,' confirms Morris. 'I've heard stories of between 30 and 50bhp drained from the 'box.'

And the jacked-up rears? This is because of the extra oil pump that is part of the system.

'The oil pump is on the output shaft, so you have to have the wheels rotating to pump the oil around the gearbox,' explains Baxter. 'This one [in the Alta] is just slightly different, but it still doesn't do any harm warming them up because each gear has its own clutch band.

'It's like a Swiss clock inside these gearboxes. They are very complicated, and they're always very generous as well because, if one bit breaks, the whole lot breaks with it.'

To ensure pre-selector gearboxes are suitably oiled and readied for action, cars like this ERA are warmed up in gear so the 'box's dedicated oil pump is operating

'Arguably, the biggest challenge is making engines – casting crankcases, blocks, cylinder heads. We'll get patterns made, then send them off to foundries to cast them, and then use a CNC machine shop with four-axis [mills] to machine them'

Simon Blakeney-Edwards, president of the VSCC and owner of Edwards Motorsport

Leaf springs, here shown on a 1920s Sunbeam Tiger, are at the heart of most pre-war suspensions, often combined with friction dampers, meaning adjustability for set-up is minimal

'And of course, if someone's running a series of racecars, they might put an order in for 20 crankshafts. If I come in with a one-off order, which one are they going to do first?

'Pistons are another example. We always use Cosworth pistons, but if I go to Cosworth saying I want a single piston, they say, "Well, that's fine, but our minimum order is 50." So, you have to ring every owner up, get maybe seven or eight owners to come in with you and all agree to have a set of pistons made. It can be done, and I've done it in the past, but it doesn't happen all the time. It might happen every 10 years.'

On top of this, some of the skills required to keep these cars running are fading away.

'It's becoming more and more difficult to have a magneto rebuilt, for example, which is a bit of a black art,' says Blakeney-Edwards. 'All the people capable of doing it are gradually dying off, and the skill has not been taken up by young people.'

Surprisingly, some pre-war racecars are still running with a remarkable number of original parts. While certainly adding to the authenticity, this can create its own issues, especially where components were made at a time when quality control was perhaps not as stringent as it is today.

'Everybody used to say that Alta castings were delicate,' says Baxter. 'The reason they were delicate is because the castings were not the best. And that was self-perpetuating, because when they used to go to the foundry to have bits cast, they would empty all the scraps and take them with them because they got a tenner off the castings, or whatever. Of course, you can imagine what the founders said when they left, "they'll have that crap back again." And so it went round and round.'

This save today, never mind tomorrow mentality can come back to bite someone many years later.

'Last season, we had a bit of an incident,' continues Baxter. 'The steering box looked like a nice casting, but it broke at Prescott – luckily in a fairly slow corner – a week after it had been doing 140mph down Goodwood's Lavant straight! You could see the break line, it just looked like granulated sugar. Time obviously hadn't helped it, but it clearly wasn't a good casting in the first place.'

That has not put Baxter off, though, and neither have all the issues involved in running a car as old as his Alta.

'It's phenomenally quick and I just enjoy driving it,' he says, 'but I also enjoy the engineering. I have as much fun in the winter when I'm rebuilding it as I do driving it.'

The 1.6-litre straight six in ERA R10B. Power units in pre-war cars racing today will often be far more powerful than in period, partly thanks to more accurate machining methods and clearances on pistons and other parts. That and better quality fuel, of course

Case study: ERA R10B

There's another notable 90th anniversary this year, for 1934 was also the year the first ERA hit the track. Morris has been a marque specialist for a long time and owns one himself (R11B), which has been in his family for over 60 years. He also runs ERA R10B, now owned and driven by Bradley Baker, a car which previously belonged to Nick Mason.

R10B is a very well known car on the circuit, an ex-Peter Whitehead B Type that was campaigned both before and after the war.

Ian Wagstaff

ERA R10B is unusual in still having its original engine block, gearbox and the aluminium bodywork it was built with in 1935, along with a steel tail section / fuel tank. Safety features? Not so much

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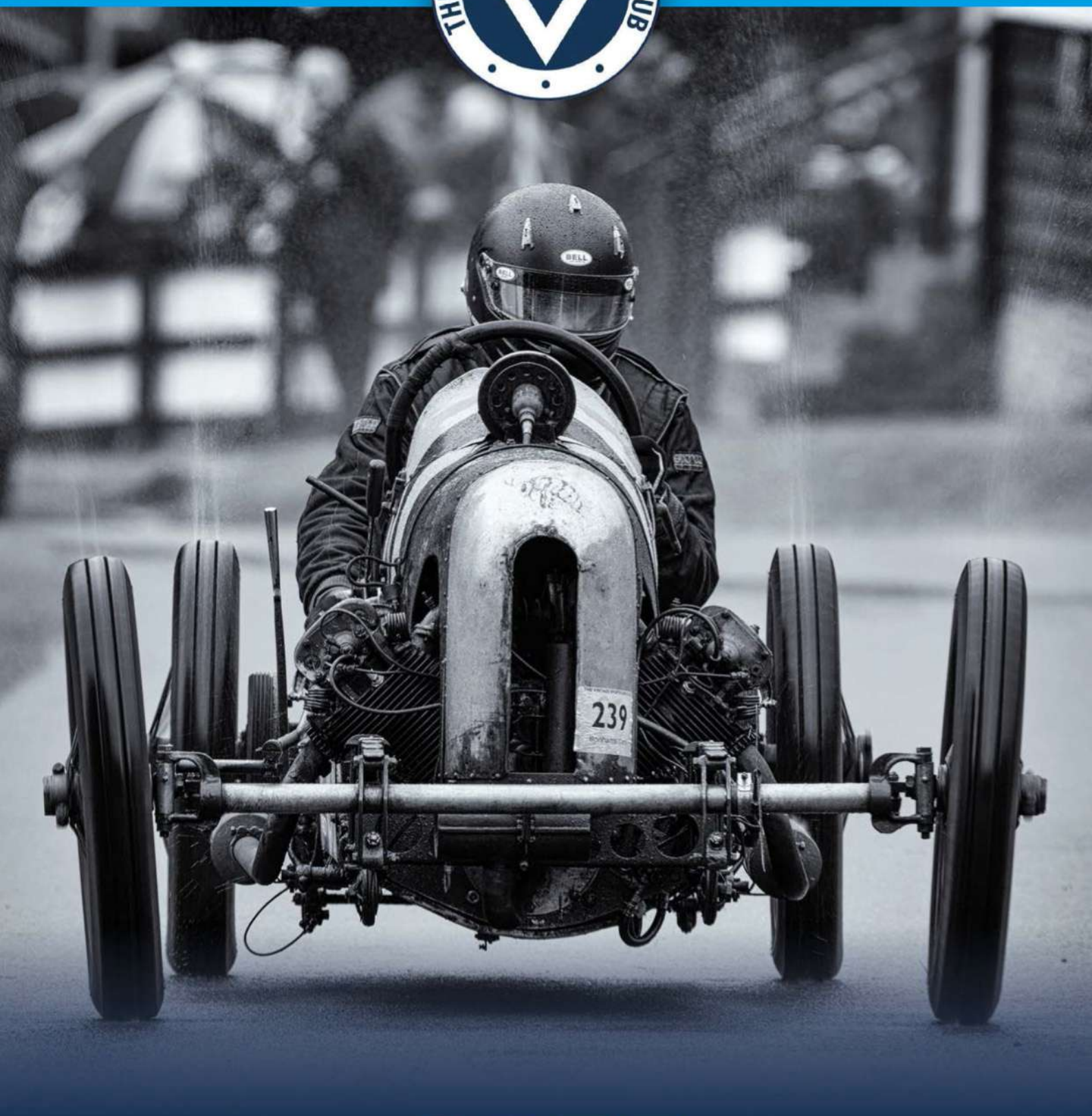

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Ian Wagstaff

Ian Baxter's Alta 61 was quite revolutionary in the 1930s in using coil springs, but no dampers. The result is a bit of an adventure every time it is out on track

'One thing that's quite unusual with this car is it's very original, which is lovely,' Morris says. 'It's got all its original bodywork. In fact, it's virtually unchanged from when it was new [in 1935]. It's still got its original block and back axle, and the magnesium case pre-selector gearbox that only went into ERAs [see box out on p38].'

The engine is a 1.6-litre straight six, with a cast iron block and aluminium cylinder head, plus a Murray Jamieson-designed bespoke ERA supercharger, and Morris says on methanol it produces around 200bhp.

U-section steel forms the chassis, while the body is aluminium, except for the steel tail, which doubles as the fuel tank. The car weighs around 750kg. It has a live rear axle, and beam at the front, with leaf spring suspension and aluminium Hartford friction dampers. With no anti-roll bars, adjustability is extremely limited.

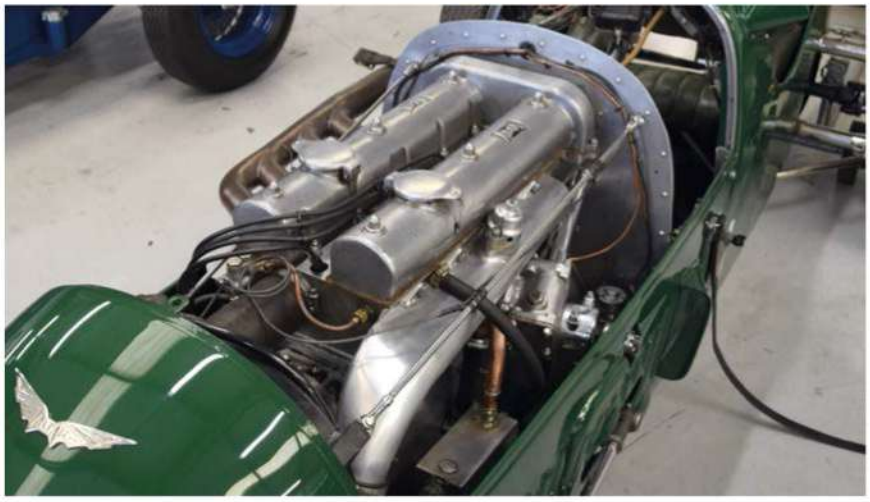
'You can soften or tighten the dampers, that's about it,' says Morris, 'but you don't want to set them too soft, as you can get to a point where the axles will start tramping.'

ERAs are spectacular to watch at speed on track, largely because they were designed to be steered on the throttle.

'Initially, they understeer, but you deliberately use the throttle to make them oversteer, and the best drivers four-wheel drift them,' explains Morris. 'If you get it right, you hardly have to touch the steering wheel in a corner. You can do it all on the throttle.'

Case study: Alta 61 1.S

In comparison to the slightly boxy-looking ERAs, Baxter's more rounded Alta 61 looks positively svelte. It is now resplendent in a green a few shades lighter than classic BRG, though it started its storied career with a rather more flamboyant paint job.



The Alta has a supercharged, 2.0-litre, four-cylinder engine that produces 250bhp, which come in all at once at 2750rpm. Because of this, the car sometimes ran with twin rear wheels in period, making its power delivery more manageable

'If you get it right, you hardly have to touch the steering wheel in a corner. You can do it all on the throttle'

David Morris of David Morris Race Preparation

'It was first commissioned [in 1937] by Philip Jucker,' says Baxter. 'He was a little wild, quite a flash devil. He stipulated that his racing colours were gold, and all the brightwork had to be silver. Unfortunately, he only had it a month before wrapping it around a tram pole on the Isle of Man, and he succumbed to his injuries.'

The car was then rebuilt and sold to George Abecassis – a real character who won the Distinguished Flying Cross during the war while serving with the RAF – and he campaigned it with some success.

Remarkably, the aluminium bodywork remains mostly original, and underneath that gleaming green metal is two boxed u-section rails, with two pairs of large parallel tubes at each end that support the suspension, plus cross bracing in the centre, while the engine is a stressed member.

That engine is a powerful 2.0-litre unit.

'In period, they said it was probably good for about 200bhp, but in actual fact, on the rollers it will produce about 250 at the rear wheels,' says Baxter. 'The trouble is, all its power comes in at about 2750rpm, because it's got this great big supercharger on the front. When that happens, you've got 350ft. lbs of torque and it comes on like a switch.

'Below that, it will bog and won't go, and it's just a pain in the whatnot. As soon as it gets up to over 2750, though, it takes off like a scalded cat, but can't cope with its power.

'Because of that, in period, it used to run twin rear wheels. I've tried it on twins, and it's absolutely great. Much safer to drive.

Ross Keeling's Delahaye 135MS is a faithful recreation of the firm's 1930s Le Mans racers, built recently but using only original parts, including the chassis and body, and to original specification

'Trouble is, with the [modern] grippy surfaces, it just shreds the diff' and rips the transmission to pieces. In one season, I broke four differentials in as many race meetings.'

The Alta has quite substantial brake drums, at 14in diameter, while it was also one of the first racecars to feature coil springs, positioned above and below vertical sliders, but no dampers. The different rates of the top and bottom springs were supposed to control the movement, which was quite a revolutionary idea at the time.

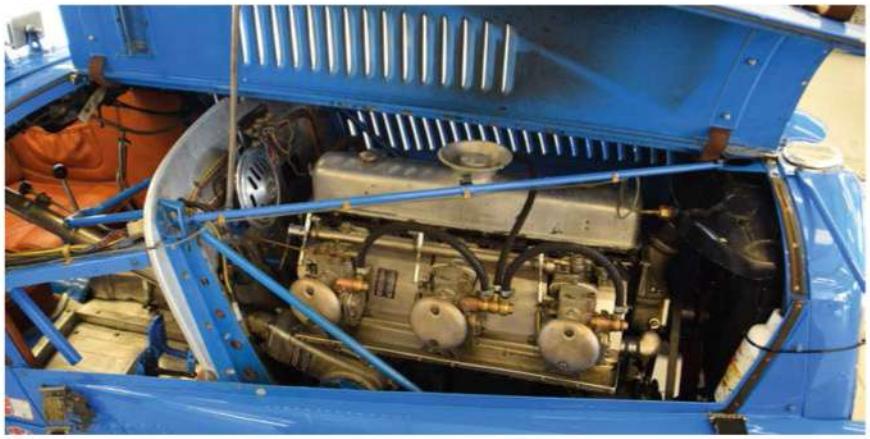
'Sometimes it works and sometimes it doesn't…' says Baxter. 'The worst thing about it is when you're on a track with an off camber, because when it goes light it sort of skips down the track. So really the handling is dreadful, but it's still great fun to drive.'

Case study: Delahaye 135MS

While the two single seaters above have long histories, and remain very much the cars they were in period, vehicles like that are rare in the VSCC. However, there are ways to race an ostensibly pre-war car, while still maintaining a respectable level of authenticity, as Ross Keeling's beautiful Delahaye 135MS illustrates.

'It's a 1936 135 Delahaye, and it's based on the competition cars that the factory made in the '30s,' explains Keeling. 'It's a recreation, but it's all Delahaye parts, and everything is to an original specification.

'When we bought it, it was just a kit of parts, but the chassis, body, frame… everything was there.'



The engine in the Delahaye is an original 3.6-litre works racing unit with triple sidedraft carburettors. While contemporary Delahaye road cars used a revolutionary Cotal gearbox, racers preferred a manual change

That chassis is c-section on the sides, boxed to add strength, while the body is an ash frame with aluminium panelling. Without fuel and driver, it weighs around 990kg, and is motivated by an original, 3.6-litre, competition-spec Delahaye engine.

'It's basically a works factory engine,' says Keeling, 'so is on three sidedraft carburettors.

'For these cars, dynos are really just for getting them set up initially and finding your oil leaks'

Ross Keeling, owner / driver of a Delahaye 135MS

We've never had it on a dyno – for these cars, dynos are really just for getting them set up initially and finding your oil leaks – but it keeps up with 8C Alfas, so it's quite powerful.'

While the roadgoing Delahayes used the then revolutionary Cotal gearbox, these were heavy, so the racecars had a regular manual 'box. The rear axle also differs from the road car, being fully floating, while it also has different driveshafts and brake drums.

The suspension is regular leaf springs at the rear, but a trans-leaf on the front, 'so it's basically front independent', according to Keeling. It also has an open diff' and Keeling reports, 'It's lovely to drive. Very predictable. You can feel it going, it doesn't snap. When it does go, it gets to a certain point and then you just have to keep your foot in and do a donut to bring it back round.'

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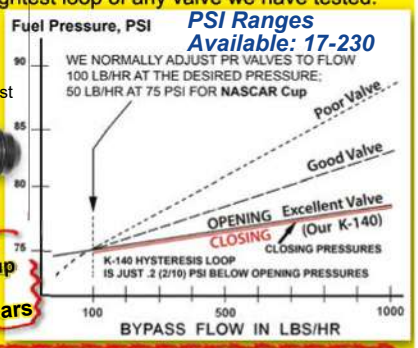

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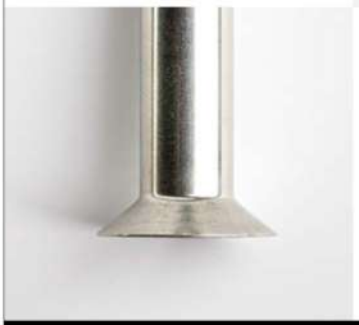

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'We try to drive it to and from most of the race meetings. And it's fun being able to take it down the pub, or go on holiday in it'
Ben Maeers, owner / driver of a GN Parker
112

Chris Tarling

The Maeers' GN Parker special has bags of power and torque and direct chain drive to the rear axle, which means it's spectacular to watch on track. This car is also regularly used on the road

Case study: GN Parker

Many of the cars on the VSCC grids are pristine, true concours vehicles, and it would be no exaggeration to suggest they are in better condition now than they ever were in period. In comparison, the aero-engined GN Parker campaigned by father and son, Justin and Ben Maeers, looks just a little bit, well, used. That's because it is.

'We try to drive it to and from most of the race meetings,' says Ben Maeers. 'And it's fun being able to take it down the pub, or go on holiday in it.'

The car is a special that began life as a GN touring cycle car in 1921. 'It's got a 6.2-litre, four-cylinder, air-cooled Cirrus-Hermes engine,' continues Maeers. 'Bags of torque. Power's about 140, 150 but, because it's an aero engine, it's all low down. It revs out at about 2000 [rpm], so it doesn't really rev at all.

'One of the problems with it is because it's got so much torque, and just four cylinders, the impulses when it fires are enormous, and we keep twisting and breaking the propshafts because they are so short.'

Gears are selected simply by engaging one of the four chains that run directly to sprockets on the rear axle, while the chassis is a very simple c-section affair with a crossmember at the rear.

'Spares are hard to get, so you have to make a lot of it yourself,' says Maeers. 'It's very thirsty, but it's bags of fun. With no differential, it just wants to slide everywhere.'

And that, in a nutshell, encapsulates what it is to prepare, run and drive a pre-war racecar. It's an adventure, a fun adventure, both on and off the track. That, many would argue, is exactly what motor racing should be.

There are four chains on the GN Parker (though two have snapped here), and gears are changed by selecting one of them. Note the very short propshaft at top of picture that takes a lot of abuse from the thumping aero engine

The GN Parker's wonderful looking power unit is a 6.2-litre, four-cylinder, air-cooled Cirrus-Hermes aero engine that produces all of its 150bhp at very low revs, topping out around the 2000rpm mark. It sounds absolutely incredible

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'Apparently, I am the only person ever to drive out of the Sant'Agata factory gates with a bare Lamborghini chassis on a trailer'

Mike Youles

The devil made us do it

To unravel the mystery of the one-off Lamborghini Diablo GT1, Racecar *spoke to Mike Youles, one of the original team behind it*

By WOUTER MELISSEN

Amos International Motorsport (AIM) developed the Lamborghini Diablo Jota GT1 with the goal of racing at Le Mans in 1995, but only made it as far as the test day. After many years in the shadows, the restored car has resurfaced to finally compete in historics

This large diffuser and a full-width rear wing were among the aerodynamic additions to the Diablo's GT1 version. Fixed headlights were installed, as opposed to the famous pop-up solution found on Lamborghini's road-going model

In 1995, Lamborghini was set to join the spectacular GT1 field for the 24 Hours of Le Mans with a Diablo that was effectively built from scratch in three months, in a converted chicken shed in Oxfordshire, UK. It was due to take on an all-star grid that included entries from McLaren, Ferrari, Lister, Jaguar, Porsche, Nismo, Honda and Marcos. No pressure then.

Despite a successful test at the Paul Ricard circuit in France, the project fell victim to company politics and, consequently, the Lamborghini Diablo Jota GT1 was never raced in anger. Largely forgotten and exiled in South Africa for decades, the remarkable machine re-surfaced in 2023 when it made its much belated competition debut, fittingly back at Paul Ricard.

One of the initiators of the original programme was racer, Mike Youles, and he now tells the story for the first time.

'Apparently, I am the only person ever to drive out of the Sant'Agata factory gates with a bare Lamborghini chassis on a trailer,' Youles says as he starts recounting his Lamborghini adventure. 'But as soon as we had gone, they [Lamborghini] did everything they could to jeopardise the project.'

Kindred spirits

Youles was an accomplished gentleman racing driver and a C2 class winner at Le Mans in 1990. Following an injury, he looked at ways to return to the Circuit de la Sarthe during the mid-1990s. In Jeff Amos and his son Steve, Youles found two kindred spirits.

'I first met Jeff when he was working at Tiga Cars and I was racing a Tiga Group C car,' recalls Youles. 'He was originally from Australia, where he had a foundry making alloy wheels for the likes of Brabham, and was such a naturally talented engineer that he was the only person working in that role for the Australian defence ministry at the time without a university degree.'

During the 1980s, Amos moved to the UK and brought Steve with him. He found work in the motorsport industry, running the composite shop at Arrows.

Extensive rule changes around that time had rendered the Group C prototype Spice SE89C, the car Youles had raced so successfully in 1990, obsolete, and instead the focus was put on production-based GT cars.

'We looked at it and thought, well, the roof is alright, and the door shuts… but the rest of the chassis was scrapped'

Mike Youles

The top-level category at the time was GT1 and, surprisingly, the homologation requirements were quite lenient, as Youles explains: 'The ACO [Automobile Club de l'Ouest] had really left the door open by stating that you only had to manufacture one road registered car to qualify.'

Very much his own man, Amos was keen to build a competition car from scratch that would meet the GT1 regulations, but the small team would have to partner with an existing manufacturer to achieve that.

'So we went to Lamborghini, because they were the only company [with a relevant model] not building a GT racer,' Youles continues. 'It was owned at the time by Tommy Suharto, who had installed an English management team headed by [former Lotus CEO] Mike Kimberley.'

His compatriot, Nigel Gordon-Stewart, was the marketing director and was keen to see a Lamborghini Diablo on the grid at Le Mans in 1995. A deal was therefore signed: 'We would fund the build of the car, they would supply the chassis and engine and we would do everything else,' as Youles puts it.

Take AIM

Backed by a private investor, the small team created a new company called AIM, or Amos International Motorsport. A workspace was rented, and an oven bought for curing the carbon fibre composite panels.

Late in 1994, Youles picked up the chassis from Lamborghini and, upon arrival, it was assessed by the team.

'We looked at it and thought, well, the roof is alright, and the door shuts… but the rest of the chassis was scrapped,' says Youles.

Amos therefore incorporated the existing roof, and the car's iconic scissor doors, into a brand new spaceframe chassis.

The biggest issue that had to be addressed, however, was the orientation of the Diablo's mid-mounted V12 engine. On the road car, the engine is installed longitudinally, but the wrong way round, with the gearbox located in the middle of the car. From the gearbox, a propellor shaft runs through the sump of the engine to the rear differential.

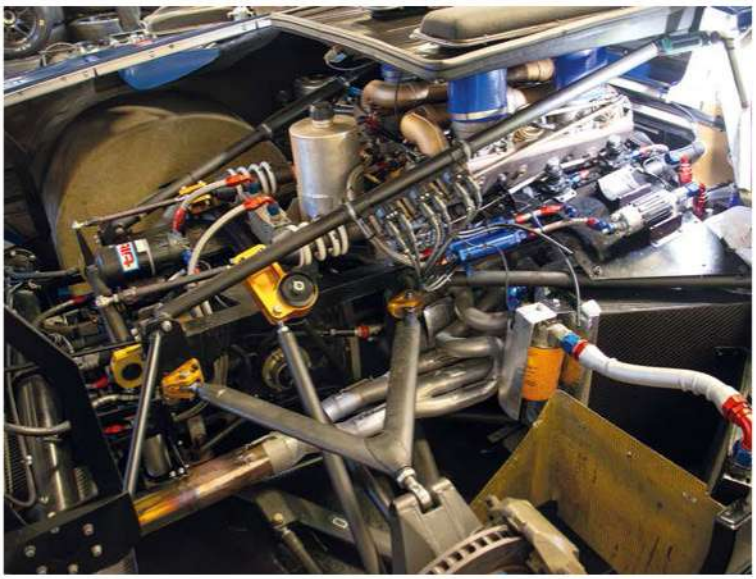
'We turned the engine 180 degrees, put our own dry sump on it and dropped it five inches in the chassis.' Youles recalls.

As the car was a purpose-built racecar, rather than a modified production car, the spaceframe chassis was very sophisticated.

After stripping and assessing the production car bought from Lamborghini, the small but determined engineering team at AIM decided the only bits it wanted to keep were the roof and the door shuts. Everything else was discarded and rebuilt from scratch

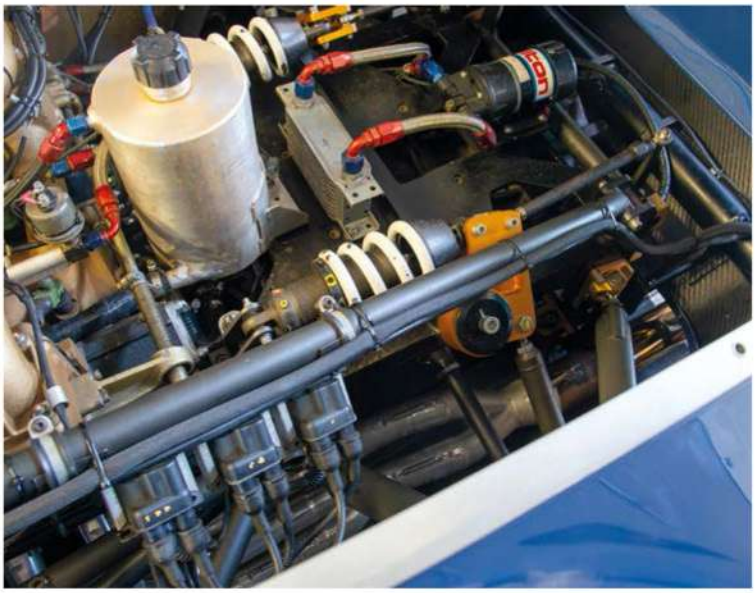
A complete new spaceframe chassis was built for the car, with integral threaded bobbins for the front suspension and mounts for a separate rear subframe. Even the dashboard was re-made in carbon fibre using the team's relatively modest in-house capabilities

The most fundamental change to the original car's architecture was to turn the longitudinally-mounted engine through 180 degrees so the Hewland gearbox is now situated at the rear rather than amidship, as it was in the Lamborghini design



Without the need for a driveshaft running rearwards through the sump to the differential, the Lamborghini power unit was lowered five inches in the chassis, greatly improving the car's c of g

There is some suggestion that the V12 engine supplied by Lamborghini with the original car was not up to scratch, leaving the team disappointed by its performance



All the major suspension components were designed and fabricated by Australian engineer, Jeff Amos

Pushrod-activated Koni dampers and springs are mounted inboard on all four corners

The homologation requirements for GT1 at the time were very lenient, requiring that only one road-registered version of the car be built to qualify, so certain features, such as the production model's iconic scissor doors, were retained in the racing version

Threaded bobbins were welded in that allowed for easy installation of components like the three-point front suspension mounts. The Lamborghini engine and Hewland gearbox were supported by a separate subframe, which included a magnesium casting mounted on top of the gearbox.

Amos fabricated all the major suspension components, including the uprights and wishbones. On all four corners, the springs and Koni dampers were mounted inboard, actuated by pushrods from the lower wishbones.

Carbon moulding

Moulds were taken from the existing aluminium body panels and used to reproduce all the exterior panels in carbon fibre. A full-width rear wing and sizeable diffuser were fitted and, in lieu of the road car's pop-up headlights, fixed units were used to further reduce weight.

On the way to Le Mans, with the car in a trailer, Youles stopped off at a UK vehicle licensing office

Even the dashboard was created from scratch in composites in the team's oven.

Intended to be ready in time for the 30 April test day at Le Mans, the dark blue Diablo Jota GT1 racer was completed in just three months and weighed a mere 1050kg.

Despite being designed and built from scratch, the whole project cost just £330,000 (approx. £655,000 / US$832,000 today).

On the way to Le Mans, with the car in a trailer, Youles stopped off at a UK vehicle licensing office.

'I presented the original Lamborghini document that had the chassis number on it and opened the trailer. One of their staff climbed in the back, looked at the car, checked the chassis number and issued what we call a V5C logbook for the car.'

This registered the purpose-built racecar for the road and, in doing so, met the very lenient homologation requirements for GT1. The team then continued on to Le Mans where the car was unveiled in the paddock.

It was not driven on track that weekend, but was assessed by Gérard Larrousse and his Formula 1 team on behalf of Lamborghini. The Frenchman had previously fielded Lamborghini-engined F1 cars and served as a trusted observer for the Italian company.

This is how the GT1 car looked as it sat for 20 years in a South African Lamborghini dealership before returning to the UK

Impressed with the work, Larrousse invited the small British team to bring the car to his facility near the Paul Ricard circuit for track testing.

Track test

Also on hand to help was Michel Tétu, who headed the Larrousse engineering team, and also designed the grands prix-winning Renaults of the late 1970s and early '80s.

Youles drove the car himself, as did Rupert Keegan, an investor in the project and an experienced racer in his own right.

'Jean-Marc Gounon was there with the Venturi 600 LM [that would go on to qualify 10th at Le Mans],' Youles recalls. 'I think we were within 10 per cent of his lap time, even though we were under geared and had to back off on the long straight.'

Keegan was so taken by the car, he said he would rather race it at Le Mans than the Lister Storm he had been signed to drive.

As impressed as he was with the car, Youles, however, was very disappointed by the engine provided by Lamborghini, commenting: 'It was rubbish; probably a basic road car engine and it smoked out of one of the cylinder banks. It was awful.'

Larrousse immediately saw an opportunity to build on work already done and floated the idea of building more road cars under the Larrousse-Lamborghini name.

Peter Stevens produced the design for a potential roadgoing version of the GT1 car, to be sold as a Larrousse Lamborghini. Amos built this model, but Lamborghini swiftly killed the project

To back up this idea, Peter Stevens, who was working as chief designer at Lamborghini at the time, penned a potential design for the proposed high performance road car.

In a mere three days, Amos turned Stevens' design into an accurate scale model, using MDF and body filler. The model was finished in the same colour purple that Lamborghini had used for its limited production Diablo SE, though, in hindsight, that might have been a mistake. For when Larrousse pitched the idea to the Lamborghini board, they said, 'If we let you make that car, we will never sell any Diablos. So that died right away,' says Youles.

Tell-tale sign

For the investor, the engine issues that showed up at Paul Ricard were a tell-tale sign of the resentment felt for the project by Lamborghini's proud Italian engineers. They presumably would have preferred to have embarked on the racing adventure themselves, and clearly had very little interest in letting a group of outsiders succeed.

Some years later, Youles ran into one of the senior Lamborghini engineers at Daytona. He all but acknowledged the long-held suspicions by saying it had not been personal.

Not interested in flogging a dead horse, the investor promptly took Lamborghini to court. He won the case and, in an out-of-court settlement, received his money back.

Under the condition that it would be raced, the unique Diablo was then sold to South Africa where it ended it up sitting dormant with a Lamborghini dealership.

'In terms of outright performance and quality, the original builders had the right ideas, but for endurance racing, changes would have to be made as access to most major components is limited'

Nicky Pastorelli, Pastorelli Classic Cars

It remained there for two decades until it was repatriated to Europe by British specialist prestige car dealer, Oakfields. Now painted white, the Diablo was returned to Italy in a shipping container. There were no drawings, but the package did include a spare V12 engine and the moulds for all the carbon fibre body panels.

Recommission job

To return the car to full running order, the Diablo was entrusted to Pastorelli Classic Cars. Based in Maranello, this restoration and preparation shop is run by Nicky Pastorelli, an ex-Formula 1 test driver and accomplished sportscar racer.

'After we received the car, it was completely stripped and rebuilt, which is common practice when a car has sat for so long,' Pastorelli explains. 'When we rebuild a car like this, small things are usually improved, but with the Diablo these changes were minimal as the original build was quite good.

'We could see that the car was still under development, but the base was there for a great racing car.'

Inevitably, when doing a rebuild for historic motorsport, making the car competitive is one of the main objectives.

'In terms of outright performance and quality, the original builders had the right ideas,' Pastorelli continues, 'but for endurance racing, changes would have to be made as access to most major components is limited, which would have made repairs during the race very time consuming.'

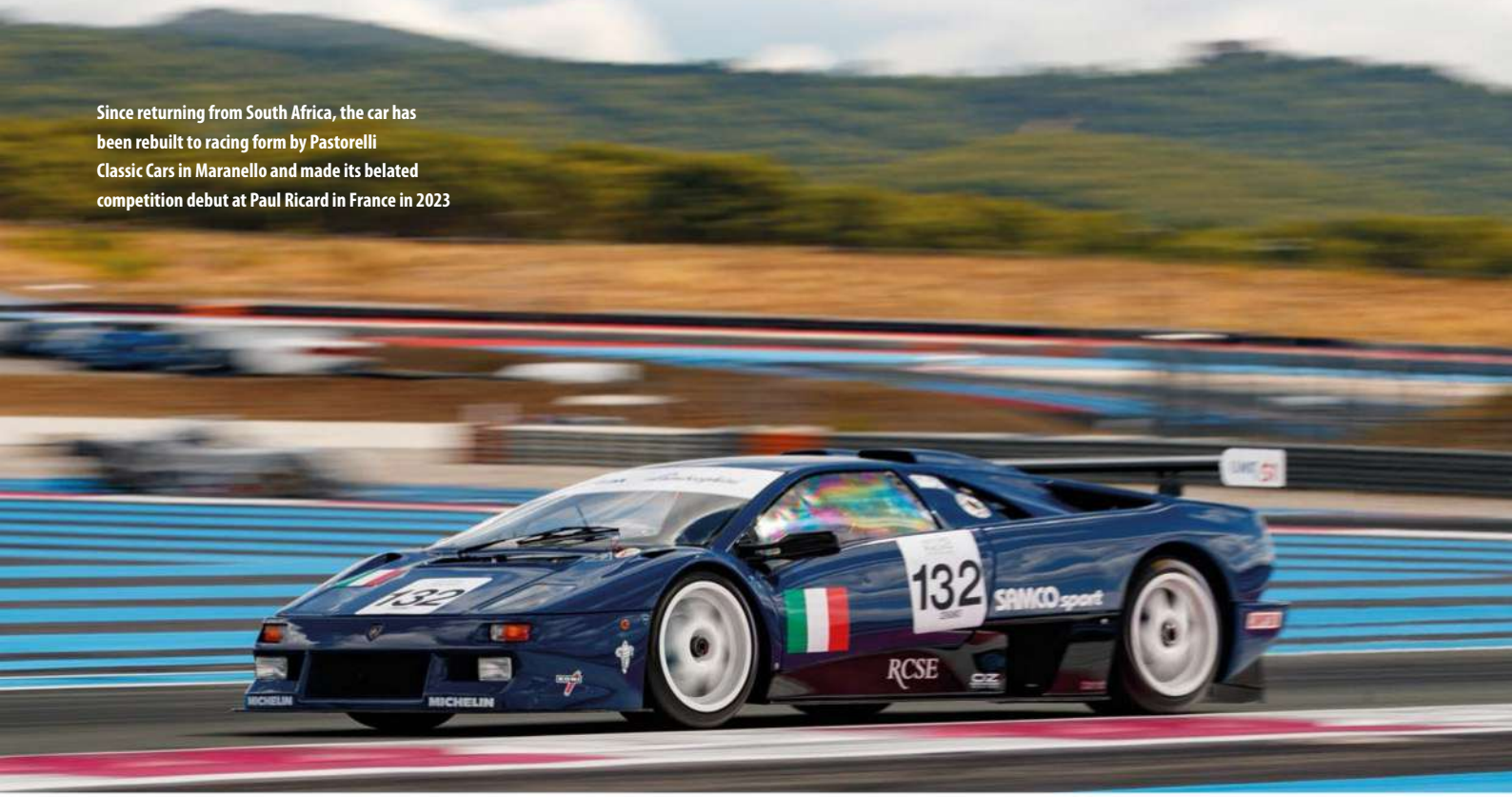
Unlike Youles, Pastorelli found no real issues with the engine fitted.

'It was rebuilt and performed excellently. We only had to make some minor changes to the cooling architecture,' he recalls.

Building a GT1 racer from scratch was an ambitious venture for anyone, let alone such a small team, working in an ex-chicken shed.

Whether the Diablo Jota GT1 would have been a success, we will never know. Unbeknown to most at the time, the car *did* offer a glimpse into the future, with purpose-built GT1 cars from the likes of Porsche and Mercedes-Benz exploiting the minimal homologation requirements baked in the regulations, which soon after resulted in the end of the original GT1 class.

Having only appeared once in the paddock during that 1995 Le Mans Test, the Lamborghini Diablo Jota GT1 has been surrounded with myths and half-truths ever since. Now that the car has returned from exile, almost 30 years later, the GT1 racer's remarkable history can finally be told.

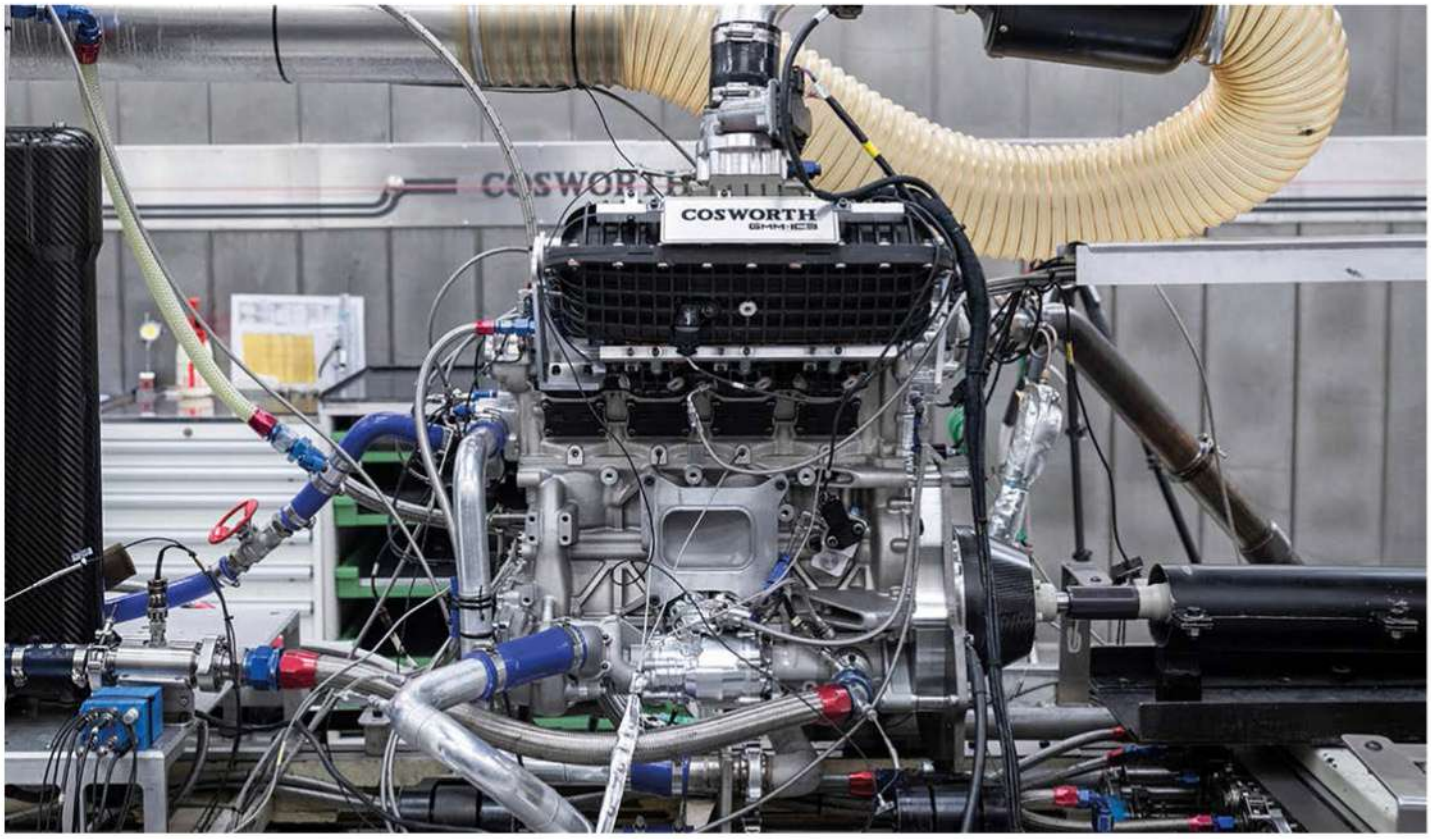


Since returning from South Africa, the car has been rebuilt to racing form by Pastorelli Classic Cars in Maranello and made its belated competition debut at Paul Ricard in France in 2023

The age of the dyno-saur

Where once an engine dyno was considered state-of-the-art, the modern racecar requires a much more complex and integrated approach to tuning

By LAWRENCE BUTCHER



Dynos are a vital tool in power unit development. Not only do they allow power and torque to be measured, they can be used to refine efficiency and optimise energy management strategies

The topic of dynos, or dynamometers to give them their correct name, used to be a relatively simple one. Racecars only had a combustion engine and the dyno was a tool to calibrate that engine and ascertain its power output. However, in the modern age, where hybrid systems and electrification are in play, the optimisation of racecars is an altogether more complex matter. Dynos and their supporting systems have needed to evolve.

A peek inside any top-flight manufacturer team in Formula 1 or sportscars will reveal a host of different powertrain test beds, featuring everything from standalone engine / motor dynos to fully dynamic, four-wheel-drive rigs capable of running a complete vehicle powertrain through realistic race simulation scenarios.

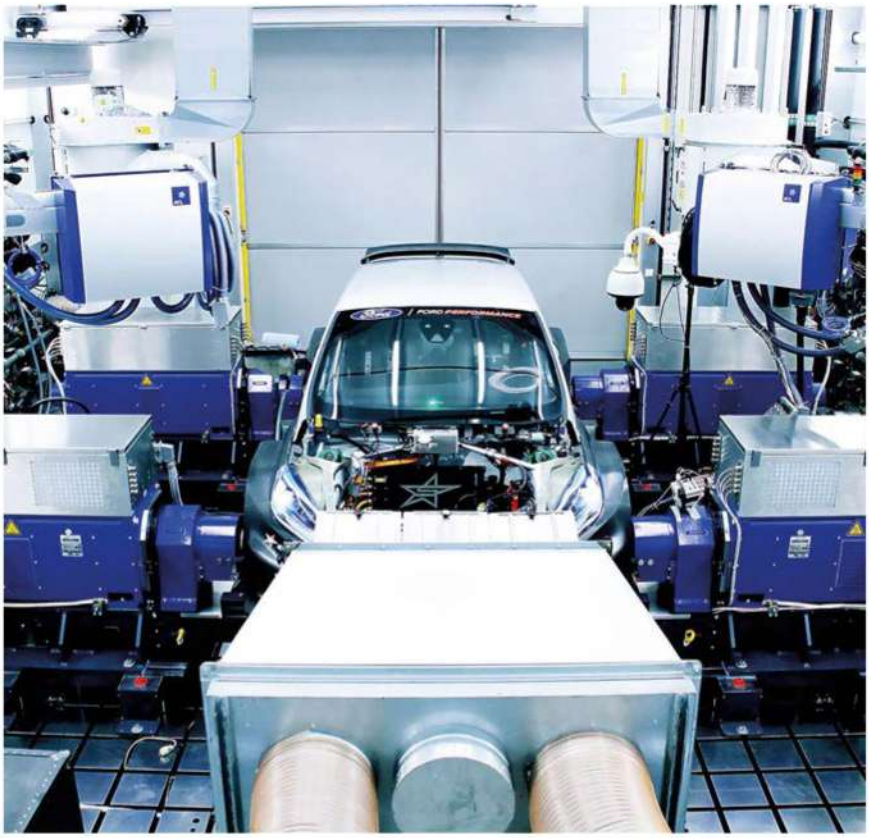
The basics

There are three distinct types of powertrain dyno. At the most basic level, one has single-quadrant dynos, capable of applying load in a single direction of rotation and used for power measurement. Two-quadrant dynos apply load in two directions, while four-quadrant units can both apply load and be motored – that is, drive rather than just absorb load – in two directions.

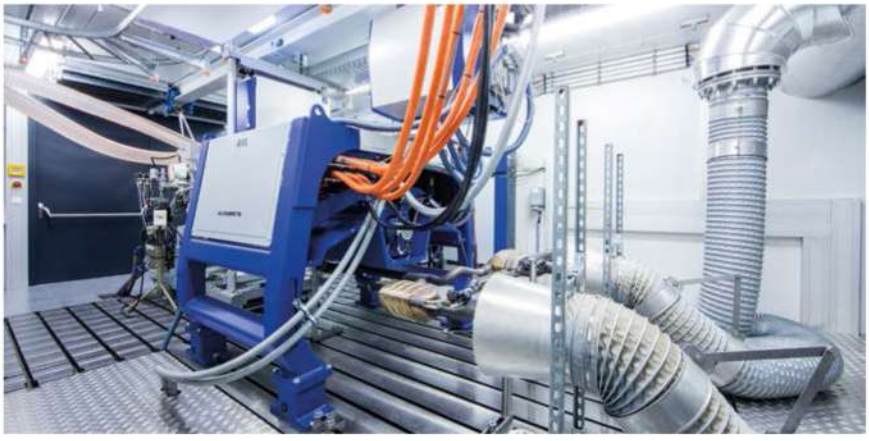
The first two categories include more traditional 'passive' dynos, which use water brakes or eddy current systems to apply load, while the more advanced four-quadrant dynos generally rely on electric motors and are often referred to as 'active'. It is this last type that has become vital for the development of today's advanced powertrains, where complex drive cycles need to be reproduced to optimise energy management strategies.

To achieve this dynamic operation, the dynamometer must be able to absorb torque from the engine and motor (and provide torque to) the powertrain being tested.

It is not just power units that are tested, dyno manufacturer, AVL, also offers a dedicated transmission test rig



A four-wheel dyno attaches to the hubs of a car and accounts for all the other ancillary systems in the test process



A traditional passive dyno applies load in just one direction and produces power and torque curves for an engine

Fine tuning on track will still be required, but a lot of time can be saved with the right test bench set up

This ability to motor is an important factor as it allows input forces to the crank (shock loadings from a gear change, for example) or energy recovery during braking phases to be simulated.

Active dynamometers with electric motors can be further broken down into those that use ac or dc motors. While both types of motor allow for full four-quadrant operation, ac motors provide better control of output torque at low speeds and have a much lower inertia than dc units, which can be important when dealing with high-revving race engines, or electric motors with very rapid throttle response.

Four-quadrant dynos can be used for multiple types of testing. These range from basic power measurements, as would be undertaken on a traditional passive dyno, which produces power and torque curves for an engine by measuring transient losses and drive cycle testing. During transient loss testing, the powertrain can be motored (without it running), with measurement of the input torque required to turn the engine providing an indication of the frictional losses in the complete system.

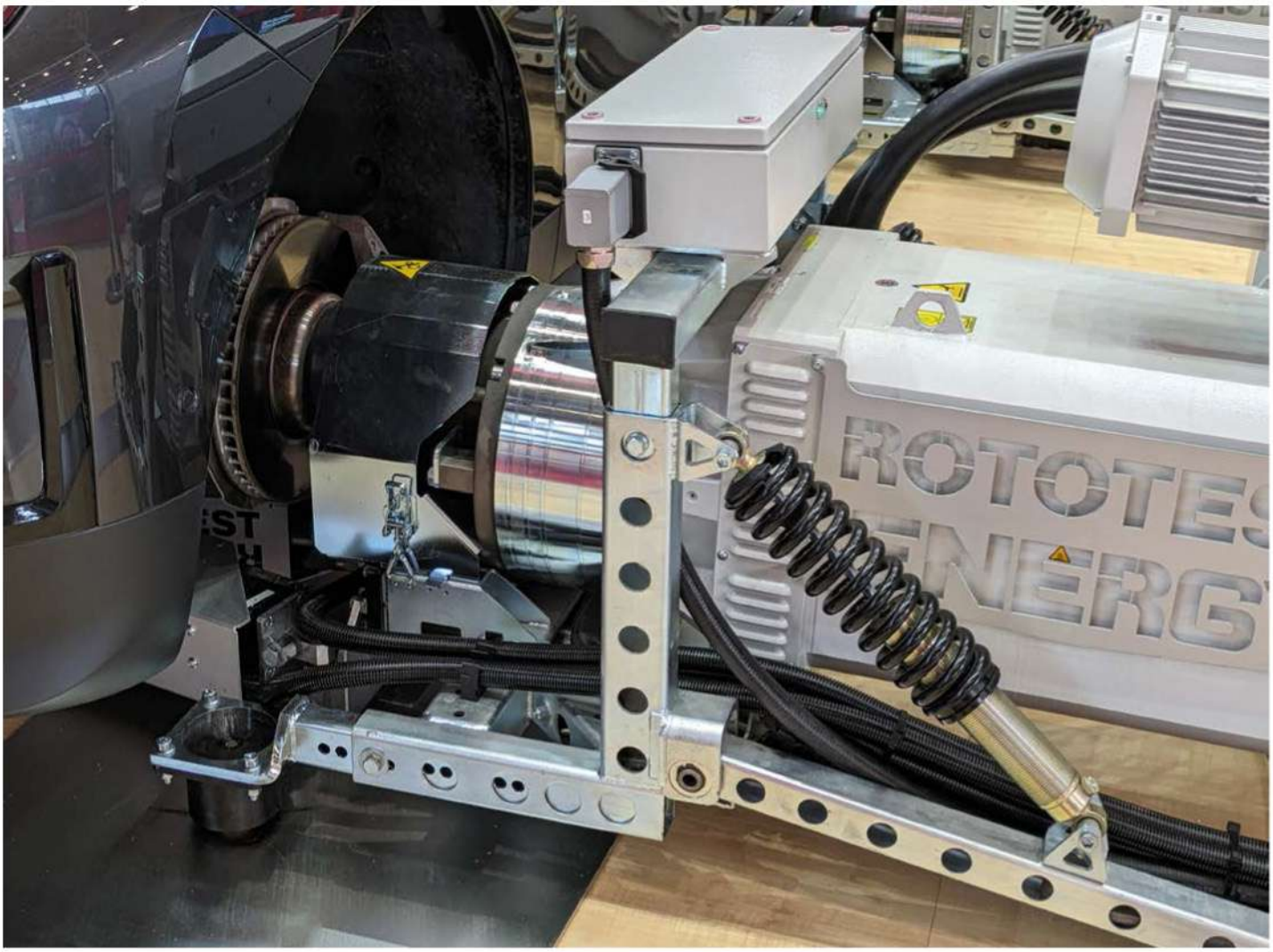
Drive cycle

It is the drive cycle testing that is the most useful attribute to development engineers, as this allows accurate simulation of engine or powertrain loads under race conditions. For example, data collected during track testing can be transferred to the dyno controller, and specific scenarios can be run through in the lab.

A great example of where this type of operation is vital is the current generation of WEC and IMSA racecars. The BoP formulae rely on torque sensors to measure powertrain output at the driveshafts. Each team must then comply with a prescribed power curve. Exceeding this curve at any point brings onerous penalties, so the trick is to run as close to the limit, as much of the time as possible, to be competitive.

This places considerable responsibility on a manufacturer's powertrain calibration team, and having a dyno set up capable of representing a realistic drive cycle, including edge cases such as kerb strikes, is needed.

For those running hybrid systems, being able to operate a complete powertrain on the dyno is a considerable bonus. Not only must the dyno be able to accurately run a cycle,



Drive cycle testing is the most useful attribute of a dynamometer to performance engineers as it allows accurate simulation of powertrain loads under race (or road) conditions

but the instrumentation needs to have the resolution to record torque spikes, which may only occur during one part of each combustion cycle. Fine tuning on track will still be required, but a lot of time can be saved with the right test bench set up.

Dynamometers can be configured in a variety of different ways depending on the overall goals. The traditional dyno cell is one approach, where the engine or motor is tested in isolation. The development of hub-mounted dynos, which connect directly to a vehicle's drive axles, now also provide a useful capability for organisations that may lack the resource for dedicated powertrain test cells, or as an additional tool for those that do. These have the advantage that the whole vehicle, with cooling and all other ancillaries, is tested. It is even possible with some systems to introduce steering and other inputs to deduce their impact on power output at the hub.

To measure the torque ripple in an electric motor running at very high rpm, it is necessary to record the torque variation over a single revolution

Torque measurement

Being able to accurately monitor the torque input / output of a dyno is vital, otherwise all you really have is a very expensive electric motor. Where once this was achieved using mechanical means, with torque arms and other such devices, any dyno worth its salt today uses a torque transducer.

Improvements in the resolution and sampling frequency of these transducers have been a significant enabler in making dynos useful for calibration of the latest ICE and electric powertrains. For example, to measure the torque ripple in an electric motor running at very high rpm, it is necessary to record the torque variation over a single revolution. This requires not only highly accurate transducers, but also very high bandwidth as motors can run well over 20,000rpm.

Systems for measuring torque operate by recording the torsional deflection of the shaft connecting the powertrain to the dyno, induced by the applied torque, by one of two methods: measuring twist angle, or surface strain or stress changes.

The twist angle method relies on a section of the dyno output shaft being reduced in diameter, allowing it to twist under load. A pair of toothed discs are then attached at opposite ends of this portion and the twist angle determined from the phase difference between magnetically or optically detected tooth / space patterns on each of the discs.

Because the discs are rotating at the same rate as the output shaft, the torque can be measured at each revolution of the engine. By adding extra discs at different angles, the resolution can be improved, enabling torque fluctuations throughout each revolution to be studied.

The traditional method of measuring surface strain on a shaft is to use piezo-resistive strain gauges mounted on its surface. When the gauge is stretched or compressed, the electrical resistance varies and, with correct calibration, this variation can be used to deduce the amount of force exerted on the material.

However, the variation in surface strain, even on a heavily loaded dyno output shaft, is

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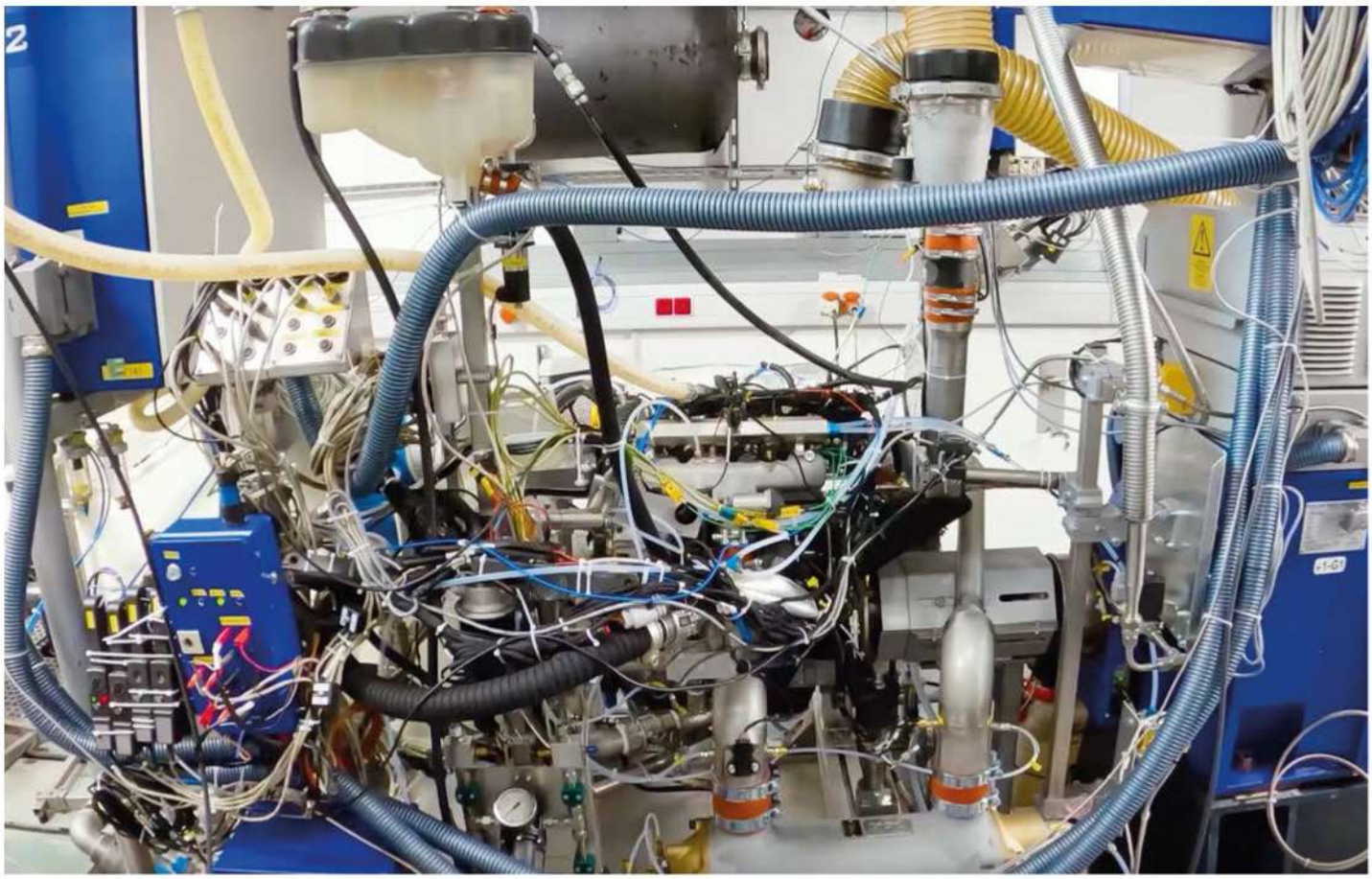

All modern racecars use some form of data logging but, free of the packaging and weight constraints of a car, a much wider array of sensors and measurement devices can be attached on a dyno

small and to measure it accurately requires precise recording of very small changes in resistance. Strain gauges are therefore almost always used in a bridge configuration with a voltage excitation source, known as a Wheatstone bridge circuit.

These sensor types are more than adequate for most dyno operations, but their resolution is not sufficient for measuring minute torque differences, and their frequency response rarely exceeds 1kHz. They are also relatively complex to package and need to be carefully protected from contamination. This is where magneto-elastic torque transducers come into play.

These sensors produce signals that are a function of torsional stress, not strain. As a result, the shaft can be made much stiffer mechanically than those used with conventional elastic torque sensors. In the case of a sensor in an engine dyno, this is a clear advantage as the output shaft that incorporates the sensor needs to be as stiff as possible to ensure both repeatability and durability.

Magneto-elastic sensors also offer a far higher frequency response than traditional strain gauges or optical sensors, in the range of 2-4kHz. A further benefit is that measuring surface stress by magneto-elastic methods is inherently non-contact, and can be packaged more compactly than twist angle or surface strain sensors.

Dynos have evolved incredibly in the last 20 years, notably with the arrival of hybrid power units that need accurate measurement

For these reasons, this is the method chosen by the FIA in the WEC for monitoring torque output on vehicles.

Infowars

Although all racecars on track these days are invariably fitted with data logging systems for powertrain and chassis, recording parameters such as pressure, temperature and throttle input, an engine on a test bed – free from packaging or weight constraints – can be instrumented to a far greater degree.

Magneto-elastic sensors also offer a far higher frequency response than traditional strain gauges or optical sensors

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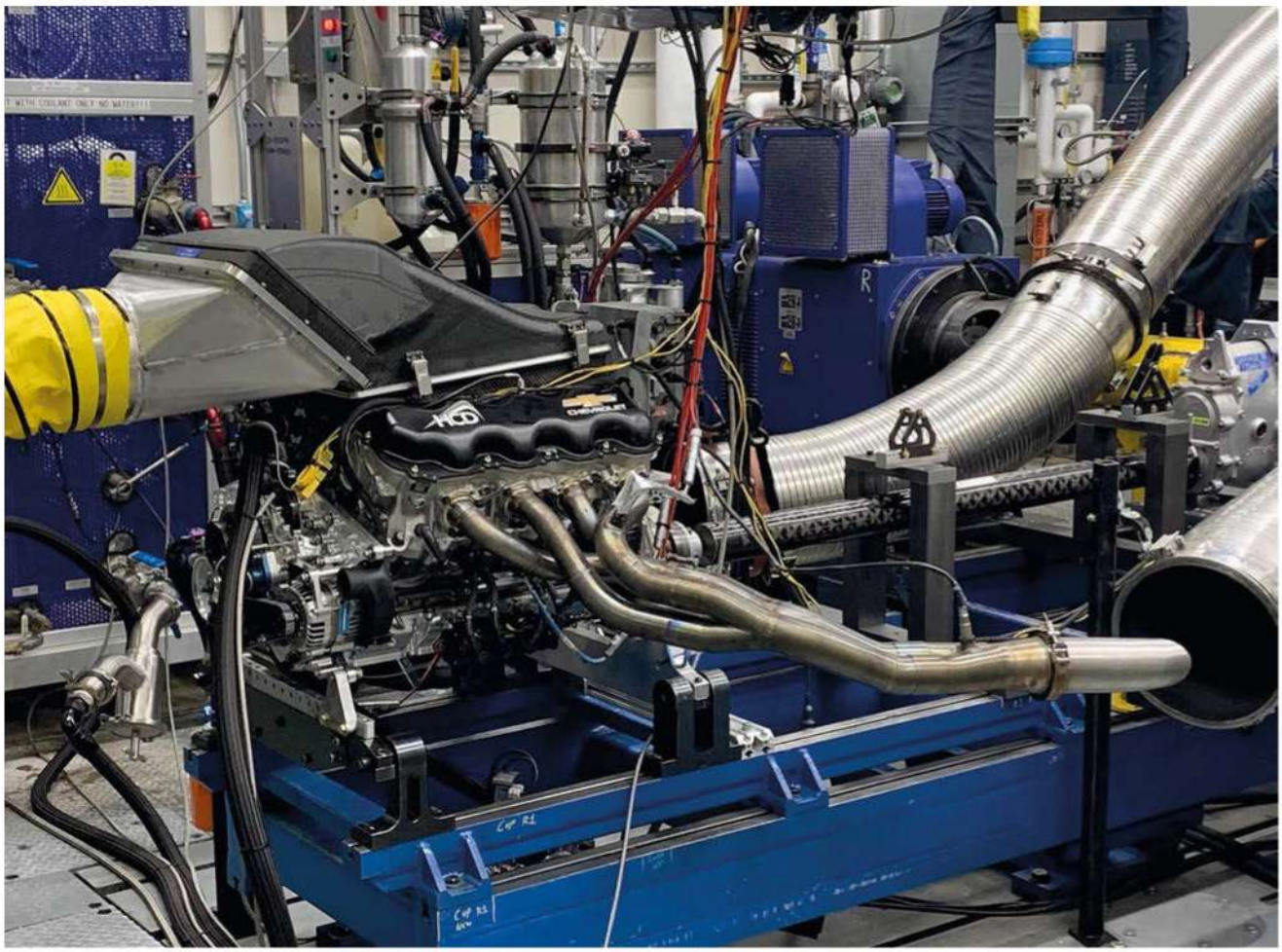

The more components that can be tested, the more accurate the overall picture. This is the full driveline dyno at GM used to develop the Garage 56 NASCAR that raced at Le Mans

The sky (or budget) really is the limit when it comes to sensors for powertrain test benches. Taking an ICE in isolation, the bare minimum sensor suite will use individual lambda probes for each exhaust port, various temperature and pressure sensors, as well as recording factors such as fuel flow.

Delving into greater detail, cylinder pressure sensors are invaluable for studying the complexities of the combustion process, while further dedicated sensors can be used for investigating vibrations in different parts of an engine.

The coolant and lubrication system can also be instrumented at various points in the systems, giving a clearer picture of temperature and pressure distribution across a powertrain, with the data obtained invaluable for validating virtual models.

Moving up a level, even greater detailed information on specific components can be obtained using specialist and bespoke sensors. For example, some suppliers can create sensing solutions to measure the forces exerted on a connecting rod, which incorporate strain gauges and built-in signal conditioning and transmission circuits, with a receiver installed externally on the cylinder block. Technology is also available to measure details such as piston temperature and loads, or factors such as piston ring displacement.

Efficiency is everything these days. Here the Global Race Engine undergoes a dyno test at Toyota's Cologne facility

Similar approaches can also be taken to other components. Clutch packs, for example, can be instrumented to investigate temperature and loading, and even the loads exerted on individual gears in a transmission can be monitored and measured.

EV sensors

Looking to electrified powertrains, there is now a raft of dedicated sensors for the study of these. Much as with ICE, sensors can be

Measurement solutions for investigating the electrical operation of high-voltage power electronics [are] important for ascertaining the efficiency of inverters and motors and isolating the sources of losses

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deployed to study temperature distribution within rotors and stators. There are also measurement solutions for investigating the electrical operation of high-voltage power electronics, which is important for ascertaining the efficiency of inverters and motors and isolating the sources of losses.

In addition to the benefits of being able to gather greater volumes of data on the test bench compared with the track, the ability to control environmental variables such as temperature and humidity also makes it easier to isolate which factors are influencing a powertrain during a run.

Media conditioning units are employed to precisely regulate the temperature and flow rate of incoming coolant and lubricant. Climactic test chambers can also be used to vary ambient temperature and pressure. These can range from test cells capable of accommodating an entire vehicle through to smaller units to hold a single battery module.

Of course, hardware is needed to allow for data from these myriad sensors to be collected, with expansion boards available to increase the capacity of standard data acquisition systems. A fully instrumented test bed can feature hundreds of sensors, all recording in real time and, depending on their role, sometimes needing to be logged at a very high rate. Not forgetting the mixture of digital and analogue signals that need to be handled, with each analogue channel requiring a signal conditioner to process its output before it is received by the data acquisition system.

Outfitting a powertrain with the systems mentioned above is time-consuming, and completing this work within a dyno cell is not a particularly efficient approach. With this in mind, many dedicated powertrain test facilities now operate systems whereby an engine, or even a complete powertrain, can be instrumented on a mobile stand before being moved into the test cell, reducing the time the cell is occupied. This approach is particularly valuable where different test programmes are under way concurrently.

Data analysis

With the current state of powertrain testing technology, it is possible to monitor almost any conceivable parameter under realistic conditions. However, this leads to vast quantities of data being collected and then needing to be analysed.

Most dynamometer manufacturers supply basic sensors and a data management interface with their systems, coupled with data analysis software and a control system integrated into a single console. The challenge then becomes one of organising the mountains of data that can be gathered. It is here that the usability of a given software analysis package comes into its own.

The challenge then becomes one of organising the mountains of data that can be gathered. It is here that the usability of a given software analysis package comes into its own

The most highly developed systems allow for many different channels to be arranged logically, and information from different test sessions overlaid for comparison. Generally, there are also facilities for creating custom maths channels to calculate specific parameters, which may be unique to a particular test.

Developments in data analysis techniques that rely on AI and machine learning are also starting to come to the fore, though delving into these falls outside the scope of this article. Of course, many engine developers will also develop their own in-house tools for data collection and analysis, tailored to their specific needs.

Suffice to say, powertrain testing is only becoming more complex and, with the ready availability of high-powered computing resources to crunch the data generated, this trend is likely to continue.

It is worth noting that there are many other test benches used by powertrain developers to investigate specific parameters. Valvetrain dynamics and turbocharger behaviour are just two examples, but that's a topic for another day.

Adapt to change

With the rise of electrified powertrains comes the need to adapt dyno cells to accommodate them. As mentioned in the main feature, high-speed electric motors require equally high-speed dynos, with the ability to measure torque over a single motor rotation at high resolution.

What is also needed is a power source for said motors, capable of replicating the battery system a motor will be used with. In some circumstances, a motor will be tested as part of the full high-voltage drive system but, when testing in isolation, a battery emulator is used. In effect, this is a high-voltage energy supply, capable of providing an accurate representation of the electrical behaviour of the battery. This can consist of a large DC power supply, capable of both discharging power (up to 1MW and beyond in some cases and over 1000V) and receiving power when a motor is used in regen' mode. The battery emulator will be hooked up to the motor inverter and can also incorporate the battery management system (BMS), or at least a model of it.

Another significant advantage of using an emulator rather than a physical battery for testing is that different battery designs can be simulated, and motors and inverters developed independently of the battery.

Battery packs themselves also need to undergo the equivalent of dyno testing, which is achieved with equipment very similar to that used to emulate them. Being able to run a pack through representative drive cycles is vital when it come to the refinement of pack designs and BMS.

However, particularly in the early stages of development, it is desirable to do this in a dedicated battery test chamber where, if there are issues such as thermal runaway, they can be safely contained. The newly installed battery test cells at Mahle Powertrain's UK facility, as an example, are fully environmentally controlled and feature a three-stage fire suppression system.

As teams and manufacturers seek ever more efficient solutions, so powertrain testing is increasing in its complexity and detail

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When you hear that the combined tyre waste from a season in F1, IndyCar, GT and rallying amounts to over 600,000 tyres, recycling them is critical to reducing the CO_2 emissions of motorsport

New rubber for old

Tyres may be the most important part of a racecar but, up until recently, they were simply thrown away after only minimal use. Here is why that situation had to change

By GEMMA HATTON

Over the last few years, we have seen plenty of promises, and steady progress, towards reducing the carbon footprint of motorsport. Most notably, Formula 1 has committed to a net zero carbon future by 2030, with the aim of reducing carbon emissions by 50 per cent and switching to 100 per cent sustainable fuel for the next era of F1 cars coming in 2026.

The latest impact report shows that the championship is on track, with the 2022 season reporting a 13 per cent lower carbon footprint than the baseline of 2018. To achieve the remaining 37 per cent CO_2 emission drop, F1, together with the incumbent teams and promoters, are continuing to use renewable energy, reduce freight where possible and maximise any and all opportunitites for recycling.

Other major series are following suit. Formula E cut carbon emissions by 41 per cent per race in 2023; the WRC was the first FIA series to use 100 per cent sustainable fuel, and IndyCar introduced a renewable fuel with 60 per cent less greenhouse gas emissions.

Although the manufacturing and transportation of tyres accounts for only a few per cent of any championship's total carbon footprint, the number of tyres used in racing is still staggering. Recycling this rubber presents a major opportunity for series to significantly reduce waste, whilst also saving CO_2 emissions.

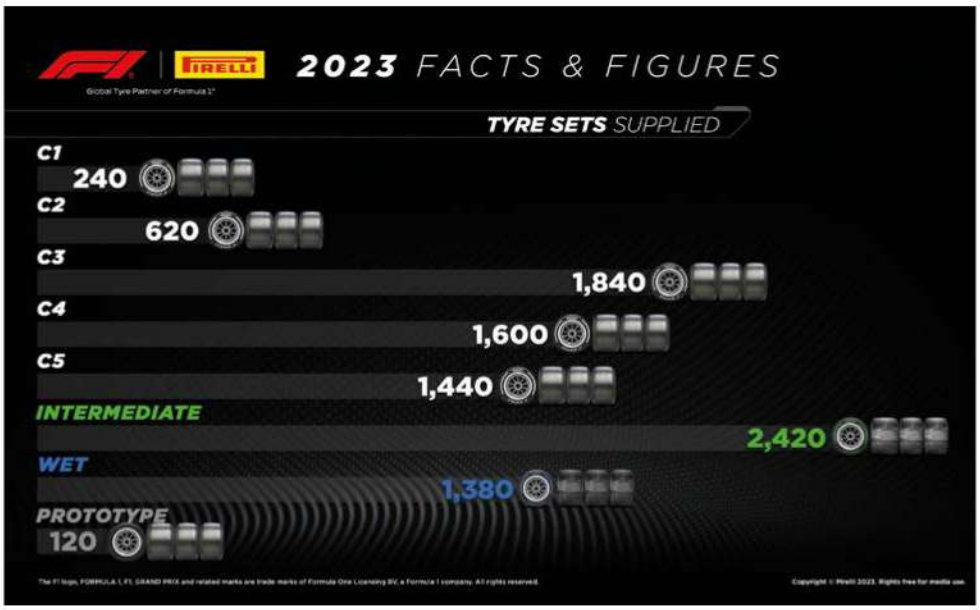
Tyre numbers

For the 2023 Formula 1 season, Pirelli supplied a total of 38,640 tyres to the teams. If you then combine the tyres used in Formula 1, IndyCar and the major GT and rallying categories, you are looking at a pile of over 600,000 tyres – for a single season.

This reflects the current problem facing the automotive industry too which, according to Michelin, discards some 3.5 million tonnes of tyre rubber every year in Europe alone.

As harrowing as these numbers are, they have triggered a movement towards tyre sustainability. Almost every major supplier is now focusing on using more sustainable materials within the manufacture of its products, as well as actively recycling used tyres into second life applications.

'Our goal is to increase the use of sustainable materials in our tyre products to 100 per cent by 2050 at the latest, and by 2030 have over 40 per cent renewable and recycled content in our tyres,' says Nels von Schnakenburg, technical manager for Extreme E at Continental.



The number of tyres Pirelli supplied to Formula 1 for the 2023 season, which is already significantly less than in previous years

Annual tonnes of CO_2 emissions from major sporting events, based on research for a Le Mans sustainability audit published in 2022

'In this context, 60 per cent of the materials used in tyre production are to be recycled from tyres by 2050 at the latest.'

Tyre construction

A typical tyre is made up of over 200 different types of material, ranging from natural rubber compounds to steel belts and chemical agents, though they break down into essentially four main parts: the bead, the carcass, the belts and the tread.

The bead is the innermost part of the tyre and is a thick section made from stiff fibres that grip the wheel rim. The carcass encompasses the sidewall and usually includes textile and / or metal cords. A series of steel or Kevlar belts then wrap around this carcass, providing stiffness. This is what is often referred to as the tyre's construction.

The 'construction' is then topped with the tread, which is a layer a few millimetres thick of softer rubber compound that generates the grip with the track's surface.

'In our Formula 1 tyres we also have an undertread, which separates the layer of tread compound from the main construction,' notes Simone Berra, F1 chief engineer at Pirelli. 'The arrangement of the belts within this construction is crucial to delivering the stiffness required to withstand the extreme lateral and longitudinal loads we see in Formula 1.'

'Tyres can essentially be divided into layers, but each layer affects the other because they all work together,' continues Berra. 'For example, how the belts deform under load affects how the tread compound deforms, and then ultimately how the tyre works on track. You can develop the best performing compound but, without the support of a well-designed construction, you won't be able to extract the performance from the tyre. Both the compound and construction have to work together effectively to deliver overall grip and performance.'

Complex process

The complex amalgamation of materials and layers within a tyre makes recycling a serious headache. Not only do all the materials need to be somehow separated, but each element then requires different processing depending on the application it is going to be re-used in.

Typically, the first stage of tyre recycling involves mechanically breaking the tyre down into its main components – rubber, steel and textile cord. The steel and textile cord can be re-used relatively easily in other applications. For example, steel can be sold to mills where it is melted in furnaces to manufacture components such as train wheels.

The recovered rubber can be used for numerous other applications, or further refined through a chemical recycling process called pyrolysis. Here, the rubber is first ground into small particles, similar to the size of a marble, and then heated at extreme temperatures in an inert atmosphere without oxygen. The absence of oxygen ensures the polymers within the tyre do not combust. Instead, the high temperatures catalyse chemical reactions, which break down the vulcanising bonds within the rubber.

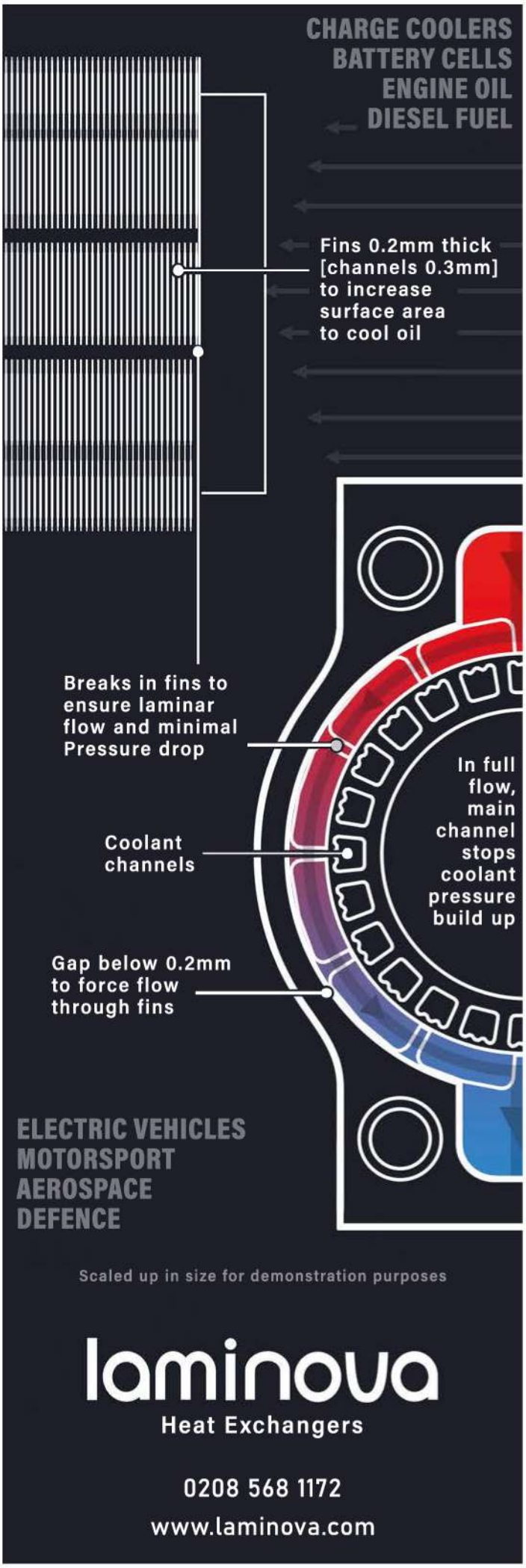
'Pyrolysis works by breaking down large molecules of end-of-life tyres into smaller molecules of their constituent parts,' explains von Schnakenburg. 'This allows the valuable raw materials contained in used tyres, such as carbon black, oil and gas to be extracted and further recycled.'

Some studies have shown that through this pyrolysis process, one tonne of used tyres can recover approximately 300kg of recovered carbon black (rCB) and 450kg of oil.

Second shot

The recovered carbon black, oil and gas can be used in a wide variety of second life applications, across many different industries. Utilising this recycled material not only minimises waste, but also reduces the amount of virgin resources needed to make new products, improving sustainability and further reducing CO_2 emissions.

Some studies have shown that through this pyrolysis process, one tonne of used tyres can recover approximately 300kg of recovered carbon black and 450kg of oil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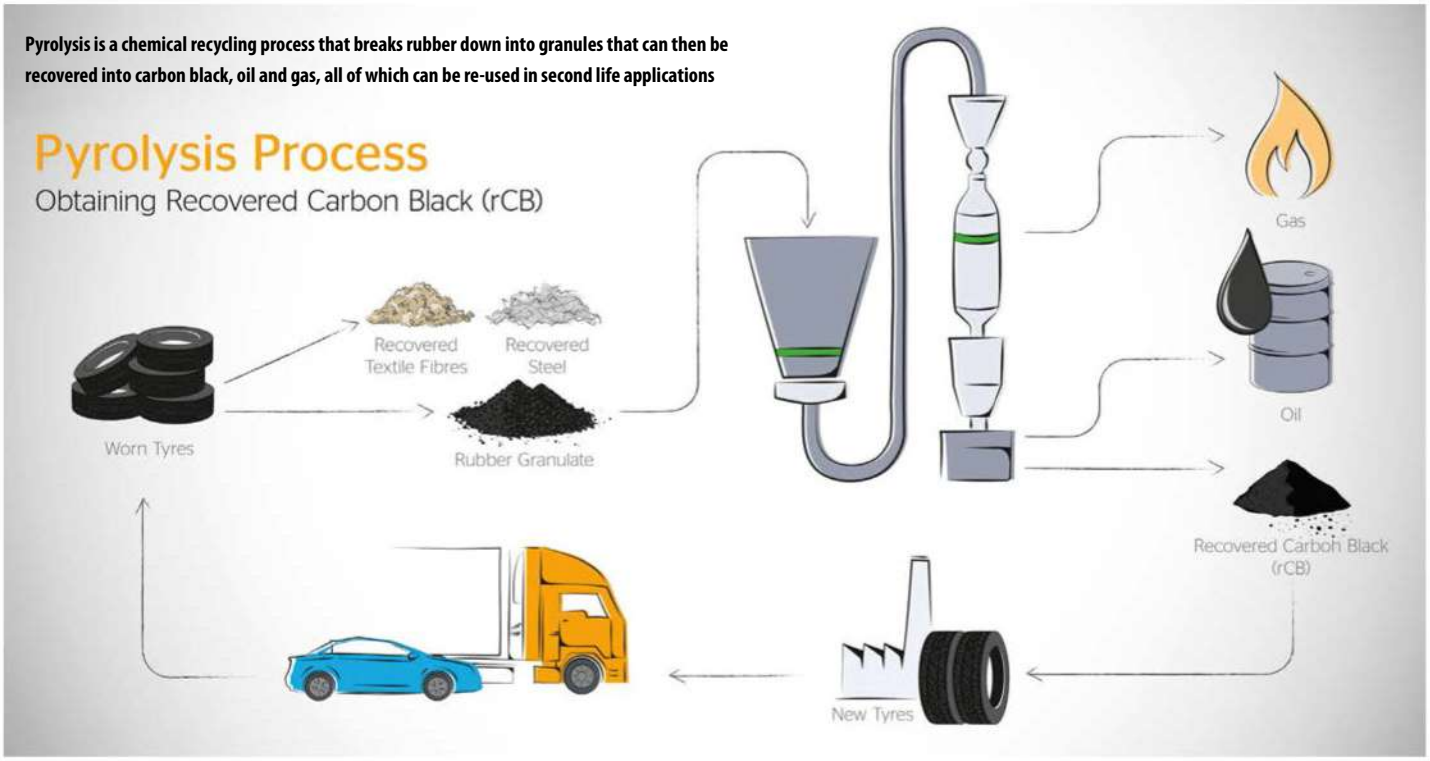

Pyrolysis is a chemical recycling process that breaks rubber down into granules that can then be recovered into carbon black, oil and gas, all of which can be re-used in second life applications

Infographic: Continental

The recycled oil can be converted to a biofuel or used in the production of chemicals, avoiding the use of crude oil. It also has similar characteristics to diesel, and so can be used as a replacement in some diesel industrial applications, too.

The recycled gas, meanwhile, is used as an energy source for the pyrolysis process itself.

The recovered carbon black (rCB) can be used in a plethora of second-life applications, including car components, pipe seals and asphalt for sports courts and road surfaces. As an example, Continental used 200 recycled race tyres from the first season of Extreme E to make a basketball court in Hanover.

Australian Supercars has recently partnered with Entyr, a company that has developed a patented thermal baking process it says can re-purpose almost 100 per cent of a tyre into higher quality materials than conventional pyrolysis. Last year, an initial trial was conducted using the 400 tyres from the championship's Gold Coast 500 round, and the intention is to scale that up to recycle all 14,000 Dunlop Sport Maxx tyres used in the Supercars, Super2 and Super3 series throughout a season.

Circular economy

Although it's great to see tyres recycled into second life applications instead of being incinerated or ending up in landfill, the ultimate goal is to recycle old tyres into new tyres – achieving a full circular economy.

'There are several circular economy solutions for recycled rubber,' explains von Schnakenburg. 'For example, the carbon black can be used as an important filler in rubber compounds, or for re-treading truck tyres.

'Typically, recycled products are not made from 100 per cent recycled material… because you need some virgin material to achieve the required material properties'

Manfred Sandbichler, motorsport director at Hankook Tire Europe

This is where recycled rubber is used to replace worn out tread strips, extending the life of the original tyre carcass.

'Continental has a long history of working to introduce end-of-life tyres into the circular economy to conserve resources and the environment. We developed a material called Conti-Reclaim, which is obtained as part of the truck tyre re-treading process at our plant in Stöcken in Hanover since 2013, and has been used in our tyre production for years.'

The burning question for those interested in motorsport, though, is can used race tyres be used to create new race tyres? Formula E tyre supplier, Hankook, certainly thinks so.

'We already ship the used tyres from Formula E to a specialist company in Europe and recycle them as much as possible,' says Manfred Sandbichler, motorsport director at Hankook Tire Europe. 'This is a difficult process because the tyres are made up of so many materials, and it is a challenge to separate them, piece by piece, but our current processes recycle around 30 per cent of the tyre, which is already a lot.

'Our ultimate goal is to take these recycled raw materials from old Formula E tyres and bring them back into the production line to produce the next generation of tyres for Formula E. I can't tell you too much, but the results from the first tests are very promising.

'Although we recycle the steel and other materials within the tyre, we especially try to get as much carbon black from the tyre as we can,' continues Sandbichler. 'It is the easiest material to recover and can be put into the regular tyre production process with minimal issues, although this process does have to be managed carefully.

'It's important we only use carbon black from recycled Formula E tyres and don't mix it with carbon black from our other recycled products, because we need the rubber to be as clean as possible. We mix this carbon black from Formula E tyres with new material and then adjust the amount of each ingredient to achieve the quality and performance we need.

'It's similar to how other materials are recycled,' continues Sandbichler. 'Typically, recycled products are not made from 100 per cent recycled material. Instead they contain a certain percentage of recycled material because you need some virgin material to achieve the required material properties.

'Formula E is the best opportunity for us to explore this technology because, on one side, the championship encourages us to be as sustainable as possible, and on the other side, it is our duty to do so. So, it is a win-win for us.

'Also, by focusing only on Formula E tyres, we can accelerate development of the process because we are dealing with smaller quantities and can have faster turnaround times than with road car tyres.'

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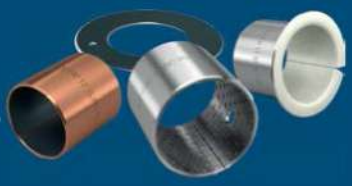

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Compound interest

Alongside the 1.5 billion tyres that go into landfill each year, so too do over 22 billion shoes. To address this waste crisis, a startup called Compound Footwear is converting used racecar tyres into 'outsoles' for shoes.

'During university, I visited a tyre recycling plant in the UK and watched hundreds of tyres get mashed up and sent to other countries as a source of fuel,' remembers Alex Witty, founder of Compound Footwear. 'To me, this seemed quite an inefficient way of dealing with tyre waste. With the infrastructure already in place to break tyres down, surely we could make something more useful out of this rubber?'

This realisation, together with a product design background in shoes, led to the birth of Compound Footwear.

'Firstly, we collect the tyres and take them to our UK facility where we clean them, removing any pickup or debris,' explains Witty. 'We then put them through a glorified paper shredder that breaks the tyre down into business card-sized chunks that still contain the metal and textile cords. This material is then further mashed and various magnets and sieves extract the metal and textile fibres, which are re-used in other applications, leaving granules of a relatively pure rubber compound for us to re-use.'

A micronization process is used to grind chunks of recycled shoe rubber into small particles. These are then melted down into a gelatinous liquid and placed in moulds. The recovered carbon black from race tyres is also micronized and a certain percentage is then added to the moulds, which are first heated and then cooled. As the liquid expands, the carbon black particles bond with the recycled shoe rubber and become suspended within the material, which is then used for the outsoles of shoes.

As with any recycled product, the trick is striking the right balance between the different materials within the mixture to deliver a part with the required characteristics, whilst using as much recycled material as possible.

'For an outsole, the main priorities are weight, elasticity and comfort,' says Witty. 'Recycled rubber from race tyres is quite a dense compound, so using 100 per cent of that would result in a very heavy shoe, not conducive to everyday wear. So we mix it with other materials, such as recycled natural or shoe rubber, and iterate the process to try and find the optimal balance between the highest percentage of recycled rubber and delivering the most comfortable, durable shoe that won't fall apart.

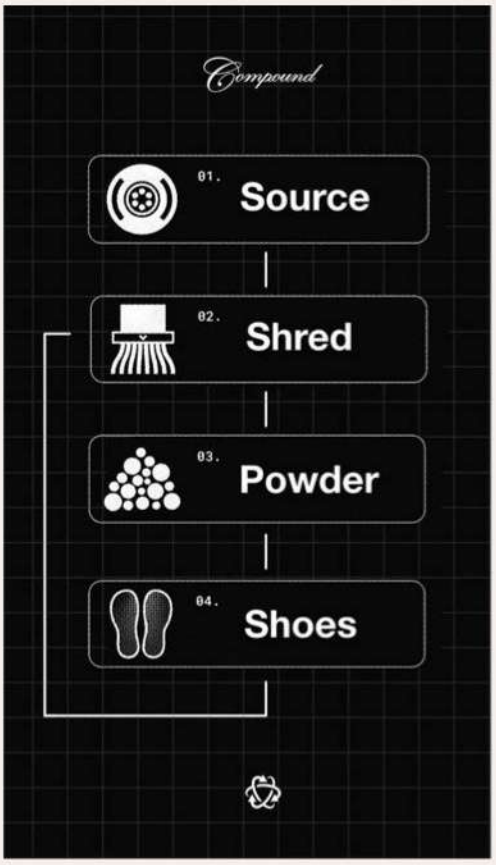
'One of the main challenges has been deciding the best compounds to use and the optimum size of particle. The easiest recycled rubber to work with is from road tyres because they are a harder compound. This is easier to micronize as it breaks itself down more easily, whereas softer compound particles have more of a tendency to stick together.

'We found that particles smaller than one millimetre were quite difficult to handle because they stick to the walls of the moulds and they actually turned the entire outsole black, which wasn't what we wanted from an aesthetic point of view.

'On the other hand, particles that are too large struggle to bond with the other recycled rubber particles. It's been a constant R&D process, but now we've got a nice balance between the recycled tyre rubber crumb size and the recycled shoe rubber crumb size, creating a black and white speckling effect on the outsole.'

As well as the outsoles, the upper part of the shoe utilises recycled leather and suede, and the startup's next goal is to develop a sports shoe using recycled motorsport apparel for the upper mesh.

'One of our long-term targets is to manufacture shoes using recycled tyres from a particular driver or race,' says Witty. 'Walking around in shoes made from rubber that won a Formula 1 grand prix would be pretty cool to offer our customers.'



Compound Footwear is a UK startup that shreds race tyres into small particles, which are then combined with recycled shoe rubber to make the outsoles of shoes

As well as using recycled rubber for the outsoles, the upper part of a Compound Footwear shoe is made from recycled leather and suede, with motorsport apparel next on the recycling hit list

Open sesame

The case for re-structuring the open-wheel racing ladder

By DANNY NOWLAN

You don't have to be a rocket scientist to figure out that the current state of open-wheel formulae is a bit unbalanced, to put it politely. Case in point, earlier this year the motorsport journalist, Will Buxton, asked on social media how would Ferrari subtitute driver Oliver Bearman cope when his Formula 2 qualifying time at Jeddah was 14s slower than the Formula 1 pole time?

Even more worrying from an engineering perspective is the growing disconnect between F1 and the junior formulae that feed it. This, and how we fix it, will be the focus of this article.

First, let's put this into perspective by winding the clocks back to the 1970s and '80s. Back then, while hardly a straightforward affair, teams *could* work their way up from Formula Ford, through FF2000, F3, F2 and F3000, all the way to the big roulette wheel of F1 and IndyCar. The last, most famous, example being Jordan Racing, which evolved into Jordan Grand Prix and is active today as the Aston Martin F1 team.

To better explain this logical progression, we only have to look at the last year of the free technical era of F3000, when testing was unlimited and pole times of those cars were within spitting distance of their F1 brethren. Little wonder, then, that the likes of Damon Hill and David Coulthard could slot straight into a championship-contending Williams F1 car and give a good account of themselves.

The problem

Fast forward the tape to today, though, and the gaps are stark. For starters, F1 is now a closed shop, and not just because the entries are so tightly controlled. The junior formulae, in particular FIA F4 to F2, are so restricted, the opportunities for teams competing in these series to graduate are almost non-existent.

To make matters worse, because of the technical restrictions in these formulae, the opportunities for engineers to learn their craft are heavily restricted as well. As I discussed in my previous article about Formula Student / FSAE, the restrictions in those mean they're not producing battle-hardened graduates who are good to go in the top-level racing series. This is something that must be addressed.

In terms of what should be happening, I think the path of my own career is enlightening because I was right on that crossover between open and spec formulae. I started in the mid-'90s in Formula Ford 1600, swinging spanners and being a gopher for the equivalent of a pie and a beer. Nevertheless, I still had the opportunity to play with four-way adjustable dampers and to size anti-roll bars.

During that time, I was also involved with Formula Holden (Australian F3000), where I was playing around with hydraulically connected third springs and data.

Later, when I was doing British F3, I was exposed to shaker rigs and what happens when you start to shift aero bits around.

Did I know what I was doing back then? No. But it laid the foundations for what I do now. That would not have been the case had the technical restrictions placed on the junior formulae today been in existence.

If you don't give young engineers the opportunity to play with things and learn how to solve real-world problems, they simply don't obtain the crucial knowledge base or, perhaps even more importantly, experience the valuable mentorship of older, more experienced engineers.

The solution

Now we know the nature of the problem, how do we go about fixing it? The first part of problem solving is to recognise there is a problem in the first place, and a huge misstep motor racing took was thinking it's all about the drivers and we need to make the cars equal. All that leads to is processional racing, as the early years of GP3 showed.

DRS addressed this problem somewhat but, ultimately, it's like using a plaster to dress a bullet wound. The solution, ironically, will come from a combination of freeing up the formulae technically, but with budget caps in place. This is illustrated in **table 1**.

Table 1: How the open-wheel ladder *should* look

	F4	F3	F2
Fixed price tub	Yes	Yes	Yes
Fixed price engine	Yes	Yes	Yes
Fixed price gearbox	Yes	Yes	Yes
Data acquisiton			
• Fixed price	Yes	Yes	Yes
• Engine temp / pressure	Yes	Yes	Yes
• Brake pressure / throttle	Yes	Yes	Yes
• Tri-axis accelerometer	Yes	Yes	Yes
• Steering / dampers	Yes	Yes	Yes
• Strain gauges	No	Yes	Yes
• TPMS	No	Yes	Yes
• Ride height sensors	No	No	Yes
• Tyre temp	No	No	Yes
• Individual wheel speeds	No	No	Yes
• Telemetry	None	Yes	Yes
Aero mods	None	Front and rear wing only	Front and rear wing, diffuser and sidepod
Wind tunnel time	None	None	5 days
External CFD time	None	2 days	10 days
External DIL time	None	2 days	2 days
K & C rig access	1 day	2 days	5 days
Shaker rig	2 days	5 days	5 days
Dampers	2-way adjustable / dampers free	3-way adjustable / dampers free	4-way adjustable / dampers free
Engine mods	None (maintenance only)	3 per year	5 per year
Push to pass	0	4	8
Test days	20	15	10
Budget (US$)	500,000	2,500,000	5,000,000

The 1980s were a glory time for the junior formulae which offered engineers experience they don't get today

The first thing you'll notice in **table 1** is all cases have a fixed price tub, engine and gearbox *and* data acquisition. Note there is nothing in the spec about who provides any of that. Reason being, another fundamental error motor racing made in the mid-'90s was to rush into single provider chassis, engine, gearbox and data acquisition. I was at ground level when this happened and remember shaking my head.

Almost 30 years later, it has proved to be a move as disastrous as the prohibition era in the United States in the 1920s. All it actually did was cull the industrial base of racecar manufacturers.

Manual shift

That's not all though. It also did something far more insidious in that it decimated the quality of what was left. Racecar manuals degenerated from vital tools into rough guides, and data systems became barely useable.

That's the 'PG' version, too. There are horror stories I will take to my grave on this subject.

The role of the engineer is to *understand* when [drivers] make a change, and to know *why* the change did what it did

Suffice to say, if you make something fixed price, rather than single supplier, not only do you allow the industrial base to flourish: you re-introduce much needed competition. And competition is what makes motorsport tick.

The next point to address is data. One of the most terrifying trends I've witnessed in my time in motor racing is the dumbing down of data acquisition. I have spoken on multiple occasions in the past about this, and yet the factory teams still wonder why they are spending a fortune and seemingly going nowhere. The correlation in **figure 1** shows what you can do with the base F4 data acquisition package.

As usual, the actual trace is coloured and the simulated is black. If a young engineer can't get close to this when working in any of the junior formulae, they are going to find themselves in very deep water on the big roulette wheel.

One thing I should expand on here is the graduation of what you have allowed in the data. So, for F4 you have the usual engine channels, with damper and steering and a tri-axis *g* meter. Anyone who has gone anywhere near ChassisSim will know this is your entry level for the ChassisSim monster file.

Driver training

One might contend that in F4, FF2000 or Formula Renault, the dominant factor is driver training, and that is true. However, the role of the engineer is to *understand* when they make a change, and to know *why* the change did what it did. This process needs to start in the junior formulae. If you don't learn it there, you won't just pick it up as you go along.

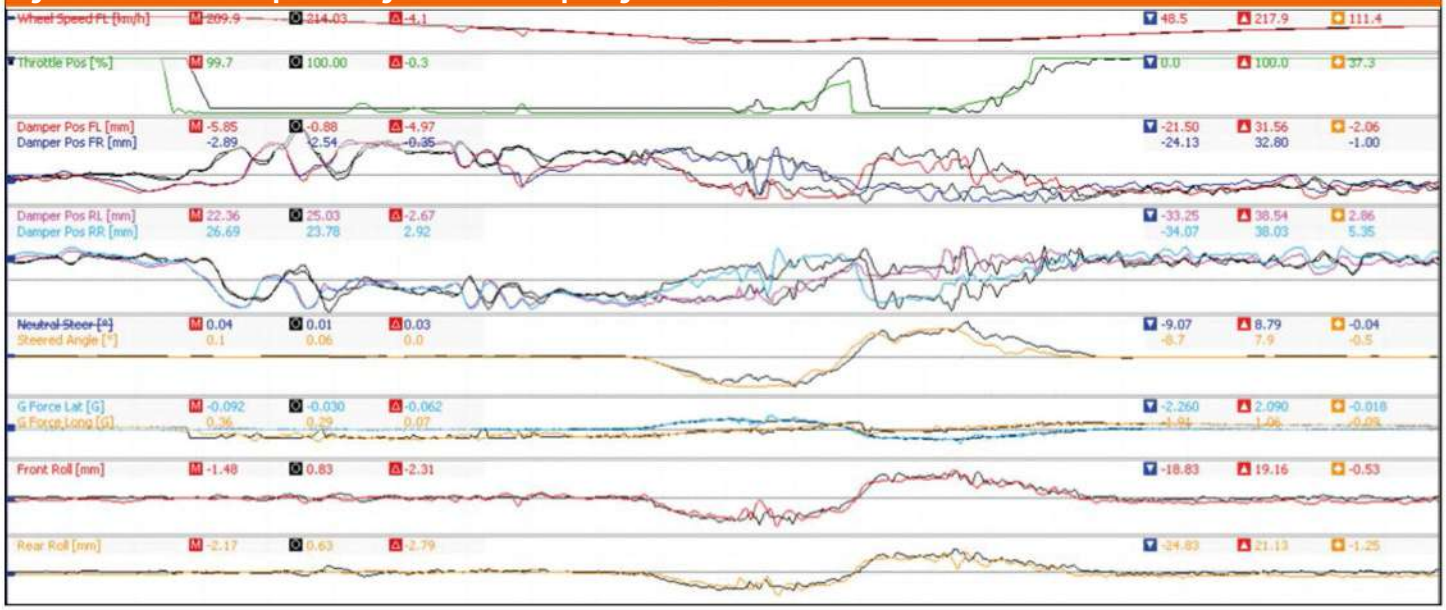
As we work our way up the motorsport ladder, you'll notice that in F3 we introduce strain gauges, TPMS and telemetry, and then in F2 you get the full shooting match of sensors. The reason for doing it this way is that you learn your basics in F4, and then introducing additional variables in F3 builds on that foundation.

You still need to be a bit smart about what you do with the data, but the all-important foundations have been built.

The reason we allow the full suite of features in F2 is because that is the final dress rehearsal before the big show. If you can't cope with the idea of working up through all these stages, one might suggest OPB (other professions beckon)!

You'll also notice in our feature spec list that dampers are free. In my view, control dampers that you can't touch are one of the worst things to ever inflict the sport. Not only do they rob engineers of hugely valuable experience opportunities, they're completely unnecessary.

Fig 1: Correlation with a Supercar using the base F4 data package



Rebuilding a Penske or JRi damper is not hard. Indeed, both companies welcome it. And with resources like the ChassisSim damper handbook and shaker rig toolbox available, you can no longer claim ignorance as a defence.

The reason we have gone from two-way dampers in F4 to three-way adjustables in F3 and to four-way adjustables in F2 is simply because it's the logical progression. Two-way dampers introduce drivers and engineers to what a damper does, and its effect. The three-way adjustable brings in the difference between low and high-speed adjustments and then, once you get into F2, you're well equipped to work with the full suite of adjustability.

Flying lessons

The elephant in the room we need to discuss here is the allowed aero mods section. One of the things I adore about hillclimbing and Time Attack is that, if you have a good idea, you can just go for it. This mentality really opens your mind to what can be achieved, particularly if you are allowed to play with aerodynamic bits.

That was par for the course in open-wheel racing in the 1970s and '80s too, but we have lost that in the years since, so we're all shocked when big money teams suddenly get caught with their pants down. Think the F1 porpoising fiasco. A direct result of not having the experience that the progression up through **table 1** addresses.

Some of the regulators reading this might think that allowing race teams to play with wings and floors will bring about the end of the world, but nothing could be further from the truth. When I was working in British F3 in the late '90s / early 2000s, I lost count of the number of times I saw wings and diffusers being repaired. I see the same happening in radio control aircraft modellers and builders, and guess what? They learn a little bit more every time.

All this comes with caveats, of course, and they are there for a deliberate reason. You'll notice that wind tunnel time is restricted. Likewise, external CFD time. This is done for two reasons: firstly, to control cost; secondly, to force teams to use off-the-shelf solutions so they learn the valuable skill of using what they have available, and building up a fundamental awareness of the numbers.

Similar restrictions pertain to shaker rig, K&C rig and external DIL rig testing. The primary reason is to keep a lid on cost, but there is another reason. With the exception of the K&C rig, shaker rig and DiL can be done in house. I should know, it's the backbone of my business.

Black box

One other thing I want to touch upon briefly here is the engine features I have outlined in **table 1**. When I look back at my career, for me the engine has pretty much been a black box you don't touch. The thing that saved my neck on this one is my tenure at Haltech working on engine management systems between 2002 and 2006. There, I was introduced to engine tuning and what engine modifications did. Guess what? It isn't as complicated as everyone thinks. But, just as with chassis / vehicle dynamics engineers, engine builders have been steadily constrained by the straitjacket of spec engines.

The final thing I want to address is the test day allowance. Without a shadow of a doubt for me, the biggest mistake made in the current era of Formula 1 was introducing the testing ban. Yes, it was a reaction to the dedicated test teams that were running nearly 365 days a year in the 1980s and '90s. Granted, that was a bit silly.

If you don't like the fact that sometimes another car will be in front of you, while other times they'll be behind you, you've chosen the wrong business

Jordan was the last team to prove it is possible to work your way up the open-wheel ladder, starting out as Eddie Jordan Racing…

…and morphing into Jordan Grand Prix which raced in F1 from 1991 to 2005, achieving four victories and 15 further podium finishes

However, the current situation is equally ridiculous. I'm going to let you in on a trade secret here, albeit not a very well kept one. Simulation and DiL rigs are no replacement for the real thing. There, I said it.

Don't get me wrong. They are fantastic tools and give you a deep knowledge of the car but, if you think they're a replacement for the real thing, you might as well deny there's a river in Egypt.

No doubt there will be some naysayers reading this that say my ideas will ruin the show. Well, the evidence against that is there for all to see in the likes of hillclimbing and Time Attack. There's never a lack of excitement there.

If you don't like the fact that sometimes another car will be in front of you, while other times they'll be behind you, you've chosen the wrong business or pastime.

In closing, then, what I have presented here is a workable game plan for opening up the closed shop of open-wheel racing and revitalising the junior formulae, so that not only can they teach drivers their craft, but engineers, too. The future of the sport depends on it.

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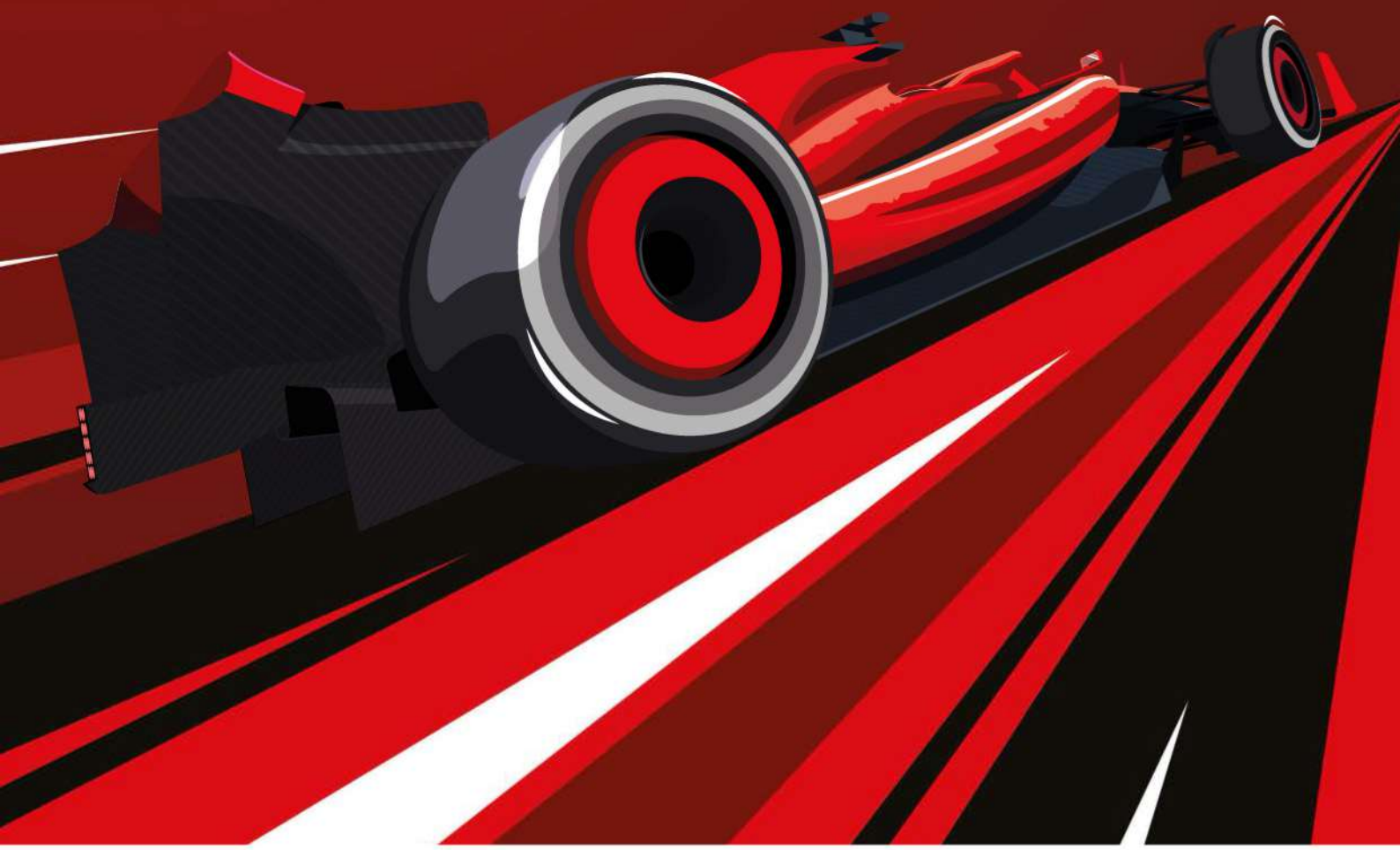

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MSV introduces new Tatuus chassis for GB3 and GB4 series

MotorSport Vision (MSV) has confirmed major upgrades to its GB3 and GB4 platforms for 2025. The Tatuus GB3-25 model features DRS for the first time, the drag reduction system part of a major upgrade to the aerodynamics that also includes an increase in downforce of 35 per cent for the same drag as the 2024 car, and improved cooling.

The GB3-25 is the first to be built to the new FIA Regional F3 regulations. It features wider tyres front and rear, 30bhp more from the Mountune engine to 280bhp and a larger fuel tank to manage fully sustainable fuels.

The car features improved front and rear crash structures, and a titanium Halo, which helps to bring the weight of the car down to 560kg, minus fuel and driver.

The Tatuus MSV GB4-025 car is a significant upgrade on the F4-T014 package currently used in GB4. Like its big brother, the car also introduces key safety features such as the Halo for the first time.

The Tatuus MSV GB4-025 chassis will retain all the updated safety features utilised in current GB3 specification, including stronger side impact and rollover protection qualities, but a lower downforce, single-plane front and rear wing package with a shortened diffuser will be introduced.

In another visual change to the current GB3 model, the conventional overhead airbox will remain a feature in GB4, with a new engine cover produced as a result.

GB4 will replace the turbocharged engine currently used in both GB4 and British F4, and will instead utilise a 2.0-litre, four-cylinder, normally aspirated Mountune unit.

The car will mirror the current GB4 power-to-weight ratio, allowing the series to continue running drivers who are 15-years old. The GB4-025 in GB4 Championship specification will retain the Cosworth Electronics SQ6 engine control unit and the Sadev six-speed gearbox with Magneti Marelli gear shift system.

The replacement GB4 car is said to be a significant upgrade over the outgoing F4-T014, with a revised aerodynamics package, improved safety and a new, 2.0-litre, naturally aspirated engine

WRC makes hybrid u-turn and guarantees rules stability

The FIA World Rally Championship has performed a spectacular u-turn on its plans to remove the hybrid system from its Rally1 cars at the end of the 2024 season, instead confirming rules stability until the end of 2026, as originally planned.

The decision to not make the previously announced changes extends to Rally2, which was going to receive an optional upgrade kit to close the performance gap to Rally1. However, damage has already been done to privateer companies that have seen orders cancelled following the decision in February to ditch hybrids and create a platform that would lead to cheaper top-class cars that could be developed around the world.

During an FIA World Motor Sport Council meeting in June, the FIA explained its decision to backtrack on axing hybrids.

'I have had a lot of conversations with the manufacturers over the past weeks about its future direction,' said FIA president, Mohammed Ben Sulayem. 'It is clear now that we all need to have technical stability for the next two years but, at the same time, it is important for the FIA that, in providing this stability, we receive the same positive commitment from the manufacturers.'

The WMSC also approved an extension to the contract with M-Sport to exclusively supply the Ford Fiesta Rally3 EVO to the Junior World Rally Championship until the end of 2025.

The WRC has pulled the handbrake on ditching hybrids mid-rule cycle and will instead offer stability to 2026

BMW launches M4 EVO

Updated M4 GT3 will be valid until 2028 and is testing at the Nordschleife ahead of a possible race debut this year

BMW's M4 GT3, which has won multiple endurance races in its short career since 2022, has received an EVO upgrade kit to make it easier to set up and to work on for the customer teams running it.

The car has new anti-roll bars on the front and the rear axles, larger rear brake discs (now 380mm), and a more user-friendly differential to make it easier for teams to place the car in the right performance window.

BMW has also focused on brake cooling in order to increase the window in which a team can change the pads during a 24-hour race. 'If we would not be limited to have to change [the brakes] between hour 11 and hour 13, that is a big improvement,' says Kurt Mollekens, co-sporting director of WRT, one of BMW's leading customer GT3 teams.

New aerodynamic features in the upgrade are smaller mirrors, larger air outlets at the front wheelarches and an alteration to the set of the rear wing compared to the existing car that will complete the 2024 season.

'I think the goal [on the aero side] was to make it less critical to pitch changes, which is mainly underneath because the front face has not changed,' confirms Mollekens.

As the car races in series governed by a BoP system, the changes are targeted to improve raceability and widen the operating window of the car to make it more suitable for different conditions.

'The main topic was not to improve the car by two seconds in lap time,' says Andreas Roos, BMW M Motorsport director. 'That makes no sense in a BoP championship. For us, it was more important to have driveability, a better car over long runs and to give our customer drivers a car that is easier to drive.'

The EVO retains the 3.0-litre, straight-six, P58 engine and Xtrac transmission from the first M4 GT3.

HORSE Power play in World Rallycross

Six-time series champion, Johan Kristoffersson, will seek to defend his FIA World Rallycross title this year in a 70 per cent renewable-fuelled, ICE-powered Volkswagen Polo, switching from the all-electric powertrain that he has used in the past.

The change has come after a new partnership was announced between Kristoffersson Motorsport and HORSE Powertrain, united by the Sweden-based Aurobay company. The team will field a pair of VW Polo KMS 601 RXs for its drivers, Kristoffersson and Ole Christian Veiby.

'In the Volkswagen Group, where I was trained, the motto has always been that all motorsport should ultimately benefit the consumer,' says Kristoffersson. 'There is nothing that drives development forward as effectively as competition, and with this project we can take part in developing tomorrow's engines.'

Out with electric, in with ICE, as Kristoffersson Motorsport partners with HORSE Powertrain

The WRX has this year introduced a unique 'Battle of Technologies' formula, which encourages different powertrain solutions, including ICE and EV, to race against each other.

'We have a brand new car, a brand new partner and a very short timespan to match the electric cars,' adds Kristoffersson.

IN BRIEF

The FIA World Motor Sport Council has given permission for **GT3** manufacturers to produce up to 300 FIA GT3-branded versions of their road cars to create a closer link with racing. The FIA branding can be used either in the cabin or on the bodywork. Porsche and McLaren have both said they will not be taking up the offer.

Formula E will create a world championship title for manufacturers, to run alongside its teams' and drivers' titles. Updated technical regulations will allow for the use of four-wheel drive in specific scenarios, such as qualifying and race start, in the Gen3 EVO car from the 2024 / 25 season.

British company, **Cosworth**, has announced changes to its leadership team, with shareholder, **Gerald Forsythe**, named as chairman, **Dr Florian Kamelger** as the new CEO and **Dr Andreas Baenziger** the deputy chairman. The latter two founded R-Motorsport, which ran Aston Martins in the DTM and GT3 series. It operated as a brand under their company, R-Motorsport. Cosworth will supply the engine to the new Valkyrie LMH car that is expected to race in 2025.

The FIA World Endurance Championship confirmed that it will require each Hypercar manufacturer to race two cars next year. Cadillac, Lamborghini and Isotta Fraschini currently have only one car each.

Rumours of new brands joining the top class were also rife at Le Mans, with Hyundai (or its subsidiary Genesis), Nissan and McLaren all thought to be in the mix.

RML Group has hired **Paul Dickinson** as its chief operating officer. Dickinson has previously held senior management roles at JLR, Bentley and Mulliner, and latterly was global finance director for Group Lotus. His appointment coincides with the announcement of major new investment in the RML Group business and a re-structuring of the Group's main engineering teams into four new divisions: power, engineering, motosport and bespoke.

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The time is nigh

Will a new UK government open more doors for the motorsport industry?

I write just a few days before a general election in the UK, which will affect all in Motorsport Valley, and the country's wider motorsport community. Forecasters are confident of a change in leadership so, based on past experience, we can expect a turbulent year ahead and a substantial change in direction.

There will be plenty of reviews and discussions on new strategies just as we see, at long last, inflation now down to the target of two per cent. Over time, the general tax take will rise, but it is unclear where and when these changes will take place, and how they will affect business.

We hear the new leadership contender aims to help 'working people' but we have yet to hear how they will differentiate such people from the mainstream.

They appear to be planning to more closely align with the European Union in some way, to change employment legislation and wages, reduce limits on immigration to increase our workforce and promise to accelerate net zero plans and associated technologies.

The proposed return of the UK's ban on new petrol and diesel cars from 2030 is a significant change, yet to be clarified, and is a tall order for the automotive industry to react to and deliver.

Whoever ends up in power, I hope they move quickly to actively help companies to increase their exports as our UK community is well engaged internationally and could grow fast, which is what they say they want.

It could achieve much more, though, with financial help for travel and accommodation to secure business. The MIA actively works with relevant government departments to awaken them to the outstanding opportunities for growth and inward investment that motorsport offers.

Wider audience

The increasing popularity of motorsport is attracting a much wider audience than in the past, while the engineering competition that is motorsport has caught the eye of investors in new technologies and mobility engineering. In recent years, we have worked hard to capture the attention of the defence, marine and aerospace sectors, all of whom benefit from working with the fast response, rapidly developed technology of motorsport teams and suppliers.

It takes time to overcome barriers, but just a short discussion and explanation of what constitutes the motorsport industry today usually attracts immediate attention.

The quality and rapidity of the development cycle in motorsport is in increasing demand. The old proverb, 'time is money', has never been more relevant in this era when cost increases are rapidly applied. Solutions are needed quicker than ever, which is a strong selling point of motorsport suppliers.

There's talk of alignment with the EU, but is it just rhetoric?

An additional benefit from this growth in popularity is that motorsport is becoming an attractive career option for young engineers, with or without degrees. The expansion of apprenticeships will increase numbers of young people who choose to avoid the debt incurred by a career based on a degree. This will bring a significant change in the next few years.

The MIA School of Race Engineering (see www.schoolofraceengineering.co.uk), delivered online and in person throughout the year, mostly attracts students between the ages of 21-28, and is growing in popularity. Our tutors are leading current race engineers, who equip these students to secure an early role in motorsport.

The period of 'new regulations' has just begun in many series across the UK, Europe and the USA. The continuing drive for sustainability and net zero solutions is taking hold of many of these new regulations and will present quite a challenge for the supply chains. F1, NASCAR, IndyCar, endurance, rallying and touring cars are all reviewing their plans for 2027 and beyond. Some initial, basic decisions made in the next few months will help development next year and lead towards delivering solutions in time for the 2027 season.

CTS24 in the Silverstone Wing is our 'free to attend and park' trade show for the motorsport technology and high-performance industry on 16-17 October. It is a valuable show, held at the perfect time to meet buyers and hear their demands for the 2025 season.

We have secured double the number of exhibitors from last year and expect the same increase in the number of visitors. Please check CTS24 on www.the-mia.com and register to meet and do new business with some great companies.

Tomorrow's world

We will host delegates from the USA, Italy and Switzerland, amongst others, and have a superb display of tomorrow's technology and products on show. This show is owned and run by the industry for the industry, so please put the dates in your diary and join us there.

A window is ajar, not necessarily wide open, so suppliers need to act fast to alert developers, collaborators and buyers of their interest in new business. The MIA actively helps members contact major series and are already enjoying early success.

We are attracting more members to our B2B events, all hunting new business and looking for new contacts. Obviously, current suppliers are in a leading position but, with so many changes ahead in automotive mobility and regulations, there are more opportunities to pursue than ever before.

We are entering an exciting period and can build early business momentum for next season. Good luck, and I hope to see you at CTS24 in the Silverstone Wing in October.

Chris Aylett is CEO of the MIA (Motorsport Industry Association) www.the-mia.com

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Inside the world of modern motorsport technology

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Opportunity knocks

Is the answer to the FIA and ACO's LMP2 dilemma staring them in the face?

The FIA and ACO have, I suspect unwittingly, given themselves a golden opportunity with the decision to shelve all existing plans for their LMP2 class, and instead focus on an all-new lightweight chassis and engine combination for customer drivers. The contracts have to be put out to tender again, wasting a good deal of investment from various companies. However, a wealth of solutions will arrive and some could be good, but I think a solution is already there, if they look.

What does the customer want in a prototype, and how could that be achieved? The customer driver wants to feel heroic, while the professional driver shouldn't become bored driving it. So, the car needs to be fast in a straight line, have less grip in the corners and set quick lap times, all while being (relatively) inexpensive, safe and easy to work on. This is not as complicated as it sounds.

The LMP675 class, the forebear of LMP2, was a jewel of a regulation set. Introduced in 2000, it allowed car builders to compete for overall victory with a small engine, lightweight chassis and even lighter bodywork. It attracted manufacturers as well as customers to compete.

There was a slight problem with it at the time. To achieve the weight limit, bodywork had to be wafer thin, so thin in fact that a stone could go straight through it (and did on occasions).

The customer driver wants to feel heroic, while the professional driver shouldn't become bored

Engine options were a normally aspirated, up to 3.4-litre, eight cylinder, or a 2.0-litre, turbocharged six. Wheels were 14in, rather than 16in for the more powerful but heavier LMP900s, and brakes were smaller, too. We had diversity in chassis manufacturers, so Lola produced the MG EX257, Gerard Welter the WR Peugeot, Reynard the 2KQ-LM, Pilbeam the JPX MP91, Zytek the 03S and Courage the C65.

Glory days

These were glory days for the LMP2 lineage, and all the cars competing could reasonably race for overall honours.

It was therefore highly disappointing to learn that in discussing the proposed new LMP2 rule set, the organisers are considering a single chassis supplier. We effectively have that now with ORECA dominating the current regulations, but new rules could present a chance for fresh competition.

Producing a lightweight, efficient chassis, with smaller wheels, smaller brakes and a nice, noisy engine is not revolutionary, but it is a tidy way to go racing. Particularly if you are a customer counting the pounds (or dollars, or yen) rather more so than a motor manufacturer. Although they, too, might soon appreciate a cheaper form of racing as their industry falters while politicians argue over what to do to save the planet.

The number of executive jets on the airfield opposite the track over the Le Mans race weekend suggests there is more to be done on that front. Apparently, General Motors' top brass arrived in three separate jets.

Defining 'modern'

One of the questions that sprung up at Le Mans was; 'what constitutes a 'modern racing engine'? Considering V8-engined Hypercars set the top three times in qualifying, the question was very relevant. It should be small capacity, lightweight, perhaps 450bhp, and be capable of running on sustainable fuel. If the ACO really wants to drive down costs, it could approach a manufacturer to supply it.

However, having already been awarded the contract to supply the next-generation LMP2 formula, Gibson Technology should have that contract respected, but there's a problem. The British company's current V8 engine for LMP2 is a lovely little unit, but it's not exactly 'modern'. Sure, it runs on modern, less polluting fuel supplied by TotalEnergies, and probably could be adapted to run on even better, less pollutant fuel in the future, but is that enough to fit the brief of a 'modern racing engine'?

Should Gibson design a new power unit altogether, then? I'm sure the engineers there would love the opportunity to do that, but it needs a strong business case behind it to pay for the development.

And there is the danger that the FIA and ACO might pivot again, and install the current Hypercar class as the top class not only the WEC, but also the European and Asian prototype grids, eliminating the need for a new, bespoke LMP2 prototype altogether. That was afterall the original plan when LMDh was introduced, but the concept turned out to be too expensive for the teams running the cars. Even with the LMDh hybrid system removed, the teams said that the chassis package was still too expensive, hence this new iteration of the plan.

The FIA and ACO continue to stress LMP2's importance as part of the endurance pyramid. But as one observer at Le Mans put it; right now they don't need the class. So they took the chance to extend the current rules until they do.

ANDREW COTTON Editor

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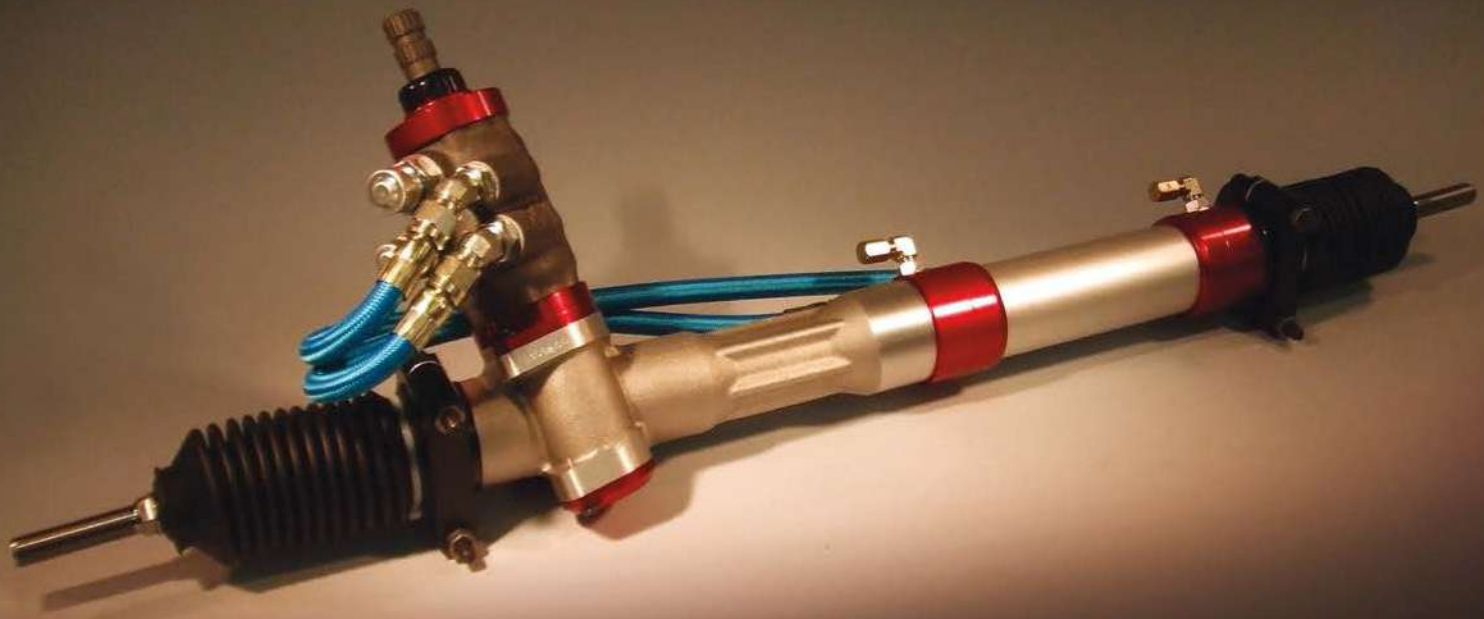

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